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ABSTRACT

The purpose of the Synergy Conference was to define and initiate new roles for industry in the systemic reform of K-12 science, mathematics, and technology education. The three specific goals of the conference were: (1) inform the corporate community about the status of education reform and its relationship to the larger economic context; (2) share information about exemplary industry and education reform initiatives; (3) generate two outputs from each participant: an action plan for themselves and their businesses and recommendations for joint efforts to create synergy. The Presentations section of this report includes the keynote address "Thinking for a Living" (Marc Tucker); summaries of the plenary session speeches: "Progress of Standards Reform in Science, Mathematics, and Technology Education" (Kenneth M. Hoffman and others); "Business and Education: The Evolving Agenda" (Gary Aslin), and "Briefing: Legislative Initiatives in the 103rd Congress" (Gary Allen); and summaries of the concurrent sessions. The "Response" section of the report synthesizes the working group discussions and includes examples of actual action plans. The "Outcomes" section lists recommendations, and the concluding section reviews the conference accomplishments. Appendices include funding, participant list, conference agenda, and a list of the members of the Synergy Conference Advisory Committee. (JRH)

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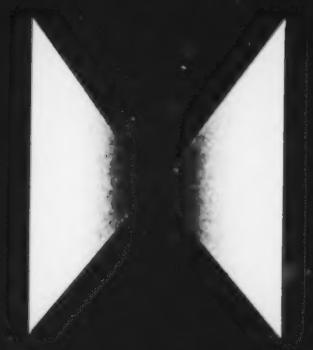

Industry's Role in the Reform of Mathematics, Science and Technology Education

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The Triangle Coalition for Science and Technology Education was founded in 1985 to join the ideas, influence, and resources of national organizations in three major sectors: business/industry/labor, science/engineering, and education. Through alliances and partnerships, these three sectors work with the Triangle Coalition to bring about the reform of science and technology education.

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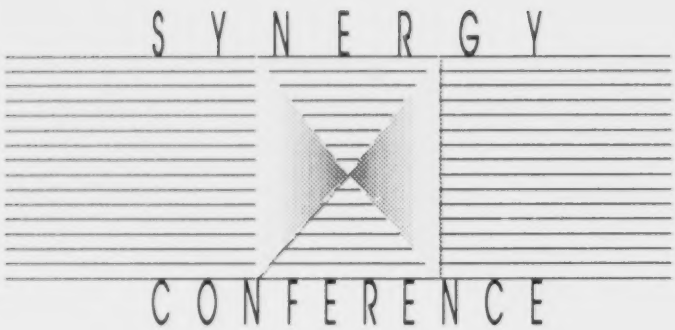

Industry's Role in the Reform of Mathematics, Science, and Technology Education

June 23-25, 1993
Leesburg, VA

Triangle Coalition for Science and Technology Education

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Executive Summary

PURPOSE OF THE SYNERGY CONFERENCE

The nation is in the midst of a unique period of educational change; at the cutting edge is the reform of mathematics, science, and technology education. With a history of trying to fix the parts, we now are attempting systemic reform. With a tradition of locally controlled school systems, we now are developing national standards.

How can industry contribute to the systemic reform of K-12 mathematics, science, and technology education? To help answer this question, the Triangle Coalition for Science and Technology Education and ten co-sponsors hosted a Synergy Conference on June 23, 24, and 25, 1993, in Leesburg, Virginia. Industry representatives listened to presentations, held small-group discussions, and developed action plans and recommendations for "synergy," where the outcome is greater than the sum of individual efforts.

MESSAGES FROM THE SPEAKERS

The U.S. is losing economic ground to overseas competitors offering well-educated front-line workers at wages a fraction of ours, said keynote speaker **Marc Tucker**, president, National Center on Education and the Economy. Advanced competitors like Germany and Japan have stayed ahead by adopting high-performance work organizations, which offer a better, more customized product but require a highly educated front-line workforce.

The U.S. has not yet learned this lesson, **Tucker** asserted. Most of our front-line workers graduate from a general

education curriculum with "basement-level academic skills and no vocational skills," he said. **Tucker** advised the U.S. to follow the lead of other advanced nations that have effective early childhood programs, clear educational standards, and strong school-to-work transition systems. American businesses should work with schools to set high graduation standards, **Tucker** believes, and should employ only those students who attain these standards.

According to panelist **Kenneth Hoffman**, associate executive officer, National Research Council (NRC), the U.S. faces unique challenges in applying national standards to "a huge, loosely-coupled [education] system with absolutely no one in charge." National standards must be specific enough to be meaningful, yet flexible enough to encourage voluntary adoption by local districts. To build true consensus around standards, all major constituencies must be involved in the development process. Standards alone will not produce dramatic changes in schools and classrooms, **Hoffman** said, unless the nation puts a support system of complementary policies and programs in place.

Lida Barrett, senior staff associate, National Science Foundation (NSF), described how the agency is shifting away from small, add-on education projects toward systemic reform initiatives for states, urban districts, and rural districts. **James Bensen**, president, Dunwoody Institute, and a speaker on the same panel, made the case for integrating technology education into the curriculum from elementary school through college. Too often mathematics and science reform initiatives omit the technology dimension—a short-sighted approach given the prominent role that technology plays in our economy and our everyday lives, **Bensen** argued.

Companies seeking to become high-performance work organizations, such as the Xerox Corporation has done, will need self-starting workers with high-level skills. This is the economic imperative for education reform, con-

cluded luncheon speaker **Gary Aslin**, director, Xerox Document University.

According to speaker **Gary Allen**, director, governmental affairs, Triangle Coalition, Congress will pass several bills affecting science, mathematics, and technology education in 1994. Most are positive, unless proposals to waive critical requirements of the Eisenhower Mathematics and Science program succeed. Budget ceilings will make it difficult to enact any major new mathematics and science education reform bill, he added.

LESSONS FROM CONCURRENT SESSIONS

Small-group concurrent sessions showcased examples of industry education reform initiatives. Common to these programs was a recognition that "real reform is not just a compilation of good projects," as one speaker said.

Several model programs—such as the Martin Marietta teacher academies, the New Jersey Business/Industry/Science Education Consortium (NJ BISEC) programs, and the SRC Education Alliance VISION program—focused on teacher professional development to bring about change. These programs went well beyond the usual one-time in-service workshop, providing intensive summer programs with hands-on learning or industry work experiences. Keys to their success were strong interactions between teachers and scientists, follow-up support during the school year, and a critical mass of colleagues committed to implementing new ideas in their home districts.

Other models, such as the Science and Mathematics Network of Central Ohio, relied on broad-based collaboration to spread reforms across school districts or regions. Speakers identified some characteristics of effective business/school partnerships: clear goals; partners' willingness to share resources and recognition; frequent meetings; a neutral convener; evaluation of both student learning and the partnership process; flexibility to change

what does not work; and a commitment for the "duration."

Five concurrent sessions updated participants on the status of national standards in mathematics, science, and workplace skills. Speakers stressed the need for industry to provide feedback on draft standards and to support implementation. The standards seek to provide all students—regardless of background, future aspirations, or interests—with opportunities to learn. In keeping with this thrust, standards will address not only curriculum, instruction, and assessment, but also the broader programs and policies needed at the local, state, and national levels to sustain education reform.

THE ACTION PLANS

The real output of the Synergy Conference came from participants who developed plans for actions that they and their companies will take to promote systemic, standards-driven reform.

Many action plans were direct and detailed. A typical short-term action (to be completed within a month) was to contact local business colleagues to discuss ideas from the Synergy Conference. A typical long-term action (to be completed within twelve months) was to reshape an existing industry program to emphasize systemic reform. Several participants said they intended to become more active in groups already working on education reform, such as the NSF State Systemic Initiatives (SSI program).

RECOMMENDATIONS FOR SYNERGY

On the last day of the conference, participants were divided into four working groups to develop recommendations for joint actions to create synergy.

Many recommendations were directed toward the Triangle Coalition, including the following:

- Produce a standard definition of systemic reform.
- Increase business and public awareness and understanding of the need for systemic reform.
- Identify and disseminate case studies of model industry initiatives for systemic education reform.
- Reach out to smaller businesses and involve them in local reform efforts.
- Translate education reform language into terms that industry people will understand and want to support.
- Strengthen the connection between mathematics and science education standards and workforce skills standards.
- Promote and coordinate regional "synergy conferences."

The Conference also directed the following recommendations at business and industry in general:

- Recognize that many employees are parents; hold parent workshops on education issues at the work site.
- Provide work-site and in-school experiences for students and teachers to help them gain better understandings of the world of work.
- Involve other grassroots community groups in local partnership initiatives.
- Develop a corporate strategy for education reform.
- Work with local educator associations to identify critical workplace skills and ensure that students are provided with them.
- Incorporate an educational focus and support for national education standards into the missions of the business organizations.
- Promote development of national electronic networks for educators.

ACKNOWLEDGMENTS

The Synergy Conference was several years in the making and its design was strongly shaped by the original planning committee of **John Laubenstein**, Amoco Corporation; **John Collette**, E.I. DuPont de Nemours and Company; **Isaac Dvoretzky**, Shell Development Company; **William Linder-Scholer**, Cray Research, Inc.; **Robert Meeker**, SRC Education Alliance; **Ralph Darby**, SRC Competitiveness Foundation; **Kendall Starkweather**, International Technology Education Association; **Richard Trocino**, Texaco, Inc.; **Cheryl Fields Tyler**, American Electronics Association; and **J. Richard White**, Merck and Company, Inc. (retired). I acknowledge their encouragement and suggestions. In addition, I want to acknowledge my appreciation of **Marc Tucker** who set the tone and direction of the conference so appropriately with his keynote address.

The conference was co-sponsored and publicized by the following associations: Aerospace Industries of America, American Chemical Society Corporation Associates, American Electronics Association, American Institute of Physics Corporate Associates, Council for Aid to Education, Edison Electric Institute, Industrial Research Institute, National Alliance of Business, Pharmaceutical Manufacturers Association, and SRC Education Alliance.

The Triangle Coalition is grateful to the U.S. Department of Energy, the Carnegie Corporation of New York, and the American Chemical Society for providing funding for the Conference. Special appreciation is due the Carnegie Corporation of New York for making the publication and distribution of this report possible.

Nancy Kober, who wrote this report, has our admiration and gratitude for taking the enormous number of words spawned by the conference and condensing and arranging them into this coherent and meaningful form. **Michelle Stoddard**, editor, Triangle Coalition, worked with **Bob McMeans** of McMeans Graphics and **Don Watkins**, photographer, to produce a document whose style and readability properly showcase the conference results.

John M. Fowler
Executive Director
Triangle Coalition for Science and Technology Education
February 1994

UNITED STATES DEPARTMENT OF EDUCATION

THE SECRETARY

**TO THE TRIANGLE COALITION SYNERGY CONFERENCE:
INDUSTRY'S ROLE IN THE REFORM OF MATHEMATICS, SCIENCE
AND TECHNOLOGY EDUCATION
LEESBURG, VIRGINIA
JUNE 23-25, 1993**

I am pleased to have an opportunity to send greetings to the Triangle Coalition's Synergy Conference on Industry's Role in the Reform of Mathematics, Science and Technology Education.

As we strive to build a high-performance educational system for the 21st century, dramatic improvement in mathematics, science and technology is critical to our success. The Federal government must work in tandem with the state and local levels to develop and achieve high world-class standards and goals. But we also must form a partnership with business, industry, education leaders, parents and communities in order to make reaching our common goals everyone's responsibility.

Through our Goals 2000: Educate America Act and our School-to-Work initiative, we are striving to produce the world's best-educated, best-trained workforce. We are grateful for the efforts and support of organizations such as the Triangle Coalition, which are working to make these goals a reality.

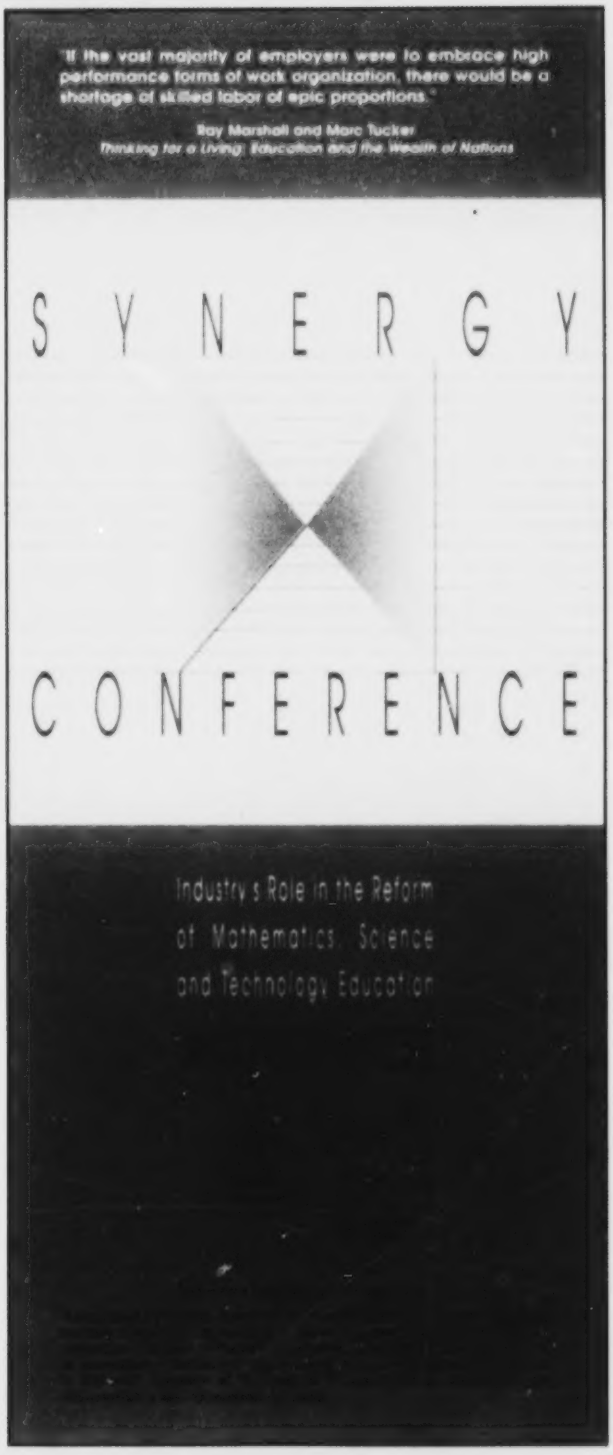
Please accept my best wishes for a successful conference.

Yours sincerely,

Dick Riley

Richard W. Riley

Synergy Conference invitation


"If the vast majority of employers were to embrace high performance forms of work organization, there would be a shortage of skilled labor of epic proportions."
Ray Marshall and Marc Tucker
Thinking for a Living: Education and the Wealth of Nations
SYNERGY
CONFERENCE
Industry's Role in the Reform of Mathematics, Science and Technology Education

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Introduction

WHY A SYNERGY CONFERENCE?

The number of industry/education partnerships has expanded dramatically since 1985, when the Triangle Coalition for Science and Technology Education began promoting alliances to improve science, mathematics, and technology education. Partnership programs now dot the U.S. map, reaching thousands of students and teachers in communities large and small. The projects spawned by these alliances have paired children with engineer "mentors," exposed teachers to frontier science, helped students see how mathematics is used in real work settings, and boosted corporate support for K-12 education to an annual level of about $10 billion.

John Fowler
Executive Director,
Triangle Coalition

But are these projects promoting the wide-scale reforms needed to prepare all students for jobs in high-performance work organizations? Are they having a significant impact on most American classrooms?

Many business leaders have come to believe that discrete, fragmented projects—no matter how numerous, large, or successful—are unlikely to produce systemic reform: comprehensive, structural changes that affect all students and teachers in a given district, region, or state.

Right now the nation is in a unique period of education reform. All fifty states and many school districts are planning or implementing initiatives to improve their entire education systems, with mathematics, science, and technology education on the cutting edge. National standards are being developed for mathematics, science, and other core subjects—an event almost unimaginable a few years ago given our history of local control of education. These national standards for instruction, curriculum, assessment, and other areas will help chart the course of reform for the next several years.

"It is time for industry to rethink its role in education reform..."

As the "customer" demanding a well-educated workforce, industry has a special stake in systemic, standards-based reform. Industry also has unique resources, expertise, and community connections that can be mobilized on behalf of systemic reform.

These events suggest that it is time for industry to rethink its role in education reform. To facilitate this process, the Triangle Coalition hosted the Synergy Conference on June 23, 24, and 25, 1993, with the co-sponsorship of ten major corporate and professional associations (See Appendix 1).

The purpose of the Conference was to define and initiate new roles for industry in the systemic reform of K-12 science, mathematics, and technology education. Participants were encouraged to design strategies that would dovetail with national standards, make efficient use of limited dollars, and promote "synergy," where the outcome is greater than the sum of the individual efforts.

Held at the Xerox International Center for Training and Management Development in Leesburg, Virginia, the Conference had three specific goals:

- Inform the corporate community about the status of education reform and its relationship to the larger economic context.
- Share information about exemplary industry and education reform initiatives.
- Generate two outputs from each participant: an action plan for themselves and their businesses and recommendations for joint efforts to create synergy.

Crucial to the Conference's success were funding from the U.S. Department of Energy, the Carnegie Corporation of New York, and the American Chemical Society. Exhibits highlighting promising industry/education programs were also available for viewing during the Conference.

CONFERENCE PARTICIPANTS

The Synergy Conference was targeted primarily at industry's *education managers*—those responsible for supporting company programs in mathematics, science, and technology education. A total of 83 people attended, more than half from industry (See Appendix 2). Participants included directors of industry education programs, directors of public affairs or corporate relations, foundation people with science and mathematics responsibilities, representatives of major scientific and engineering associations, decision-makers from government agencies, scientists and engineers from industry and government, and members of national alliances.

FORMAT OF THE CONFERENCE AND ORGANIZATION OF THIS REPORT

The Conference schedule included a variety of forums for learning, information sharing, discussion, and whole-group and small-group interaction (See Appendix 3).

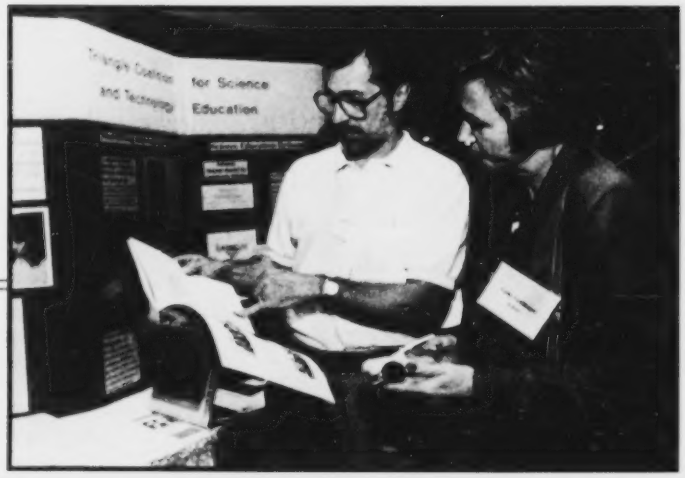
The entire conference convened on the opening day for a keynote speech and a panel discussion, and on subsequent days for a luncheon speech and a briefing. The second day of the conference was devoted to small-group concurrent sessions. The *Presentations* section of this report includes the entire keynote address by **Marc Tucker**, summaries of the plenary session speeches, and summaries of the concurrent sessions.

To allow time for interaction and the development of action plans, participants were divided into four working groups that met twice during the Conference. The *Response* section of the report synthesizes the working group discussions and includes examples of actual action plans.

Working groups also were given the task of formulating recommendations for synergy to be undertaken by the Triangle Coalition and others. Group leaders presented these recommendations to the entire Conference in a final session. The *Outcomes* section of the report lists these recommendations, and a *Conclusions* section reviews the Conference accomplishments.

The Finer Points: Shyrl Orrego Scalice, *Eastman Kodak Company*, was only one of the many exhibitors at the Conference promoting innovative and extraordinary programs developed for the improvement of education.

Food for Thought: At the Triangle Coalition exhibit booth, Cathy Genkinger and John Peppas of *Bellcore* consumed the latest information on systemic reform.



Conference Presentations

KEYNOTE ADDRESS: THINKING FOR A LIVING

Marc Tucker
President
National Center on Education and the Economy

The Synergy Conference was fortunate to have as its keynote speaker **Marc Tucker**, president, National Center on Education and the Economy. **Tucker** has been a leading thinker on such issues as designing a national school-to-work transition system, creating "break-the- mold" schools, and developing performance-based assessment for students. Drawing from the book he co-authored with Ray Marshall, Thinking for a Living: Education and the Wealth of Nations, **Tucker** challenged Conference participants to view education reform as an issue of economic survival and to develop collective strategies for deep structural changes based on high standards.

(Tucker's speech printed verbatim.)

Thank you, John. I congratulate you on the achievements of the Triangle Coalition. You had, I think, a larger vision than most of what was coming in American education reform. You saw what would be needed was a coalition of many people working to produce the kinds of changes needed by this country. I think a lot of people are very grateful to you, John, not only for having made the effort, but for having persevered. Thanks.

As John has said, I have written a book with Ray Marshall, who was Secretary of Labor in the Carter Administration, which goes into the theme of this conference at a far greater length than I will be able to in the next few minutes. I hope the book commends itself to you over the next few months.

I can sum up a good deal, I think, of the opening chapters of this book by telling you a couple of stories. In 1986, when I was still connected with the Carnegie Corporation of New York, I drafted a report for our Task Force on Teaching as a Profession, which began with a story. It was the story of the Samsung Electronics Corporation, which had a major production unit right outside Seoul, Korea, with employees who were working 363 days a year, 12 hours a day, and making $3,000 a year. They were working for roughly one-tenth of the wages of American production workers in the electronics industry and were producing home-video recorders for sale in the United States under a number of brand names which would be quite familiar to you, including J.C. Penney. We could not then, nor can we now, make home-video recorders to compete with South Korea and the other nations [making them], because they can produce them with the same standards of quality that we can at a cost with which we cannot compete.

About a month ago, I read a story in the New York Times. It was the story of a CEO of a major South Korean manufacturing firm who had lately realized that across the North China Sea from South Korea going directly west, he could make what he was making in South Korea using Chinese workers for one-tenth of the labor costs per hour that he had to pay in South Korea. All of you, I'm sure, can calculate what one-tenth of one-tenth is, and you

will get the right relation between the cost of Chinese labor and the cost of labor here in the United States. That's my first story.

My second story has to do with a visit I made to Jakarta, Indonesia, two and a half years ago. It was in January of that year, and I found myself in the offices of the president of the American Chamber of Commerce in Jakarta. I had a chance to ask him a question I had been dying to ask the right person for a long time. What I wanted to know was how, in his view and that of his colleagues, the quality of labor they were able to get in Jakarta compared to the quality of labor that they could get in the United States: same jobs, same companies, two different countries.

His answer to that question was that they could, without question, get a higher quality of entry-level labor in Jakarta than in the United States: same jobs, same companies. Now interestingly, what he was doing was comparing the quality of labor that they were getting out of the primary school system in Indonesia with the quality of labor that we're getting out of the secondary school system here in the United States. In Indonesia right now, it's a good deal like the United States was around the turn of the century. Most of their kids are in primary school, a very small proportion in secondary school, and almost all of the kids in secondary school are going to college. Secondary school is prep school, as it was in the United States at the turn of the century. A small fraction of their kids are in secondary school because a small fraction go to college.

In Indonesia, when you're getting out of primary school, American manufacturing firms provide among the most prestigious and most financially rewarding of entry-level jobs. So they are highly preferred. The American firms get the cream of the top of the bottom 80% of kids coming out of primary school in Indonesia.

In the United States, close to 60% of our high school graduates go on to some form of further education, leaving the bottom 40% for our firms for entry-level employment. Working on the assembly line is not the most favored form of employment for kids looking for entry-

level work, with the result that our firms here in the United States are lucky if they get the top of the bottom 30% of kids in the United States. That's why the difference in quality of labor.

In a world made smaller by modern communications and modern transportation, it is inevitable that you will have an integration of the world economy.

Now let me just put all of this together. What these two stories or perhaps it's three stories amount to is really very simple. Any employer worldwide with enough resources to engage in operations extending beyond one's country is a fool if he or she does not make the components for that product in that country which provides, overall, the least cost and the highest quality for the dollar; assemble them in another country or the same country which does the same thing; and sell them in third countries which are the best markets. If you don't do that, you're out of business because your competitor will.

What I was just telling you, in essence, was that it is now the case that for most products and a growing number of services, you can get labor, which is a very high component of cost in many industries, at a tiny fraction of what you would have to pay in the United States—labor often well qualified or better qualified for the work than what you can get here. The arguments for doing it elsewhere are overwhelming.

Now you could say that this is inevitable. In a world made smaller by modern communications and modern transportation, it is inevitable that you will have an integration of the world economy. You will begin to develop one market for front-line labor which is worldwide—all members of which will compete with all other members and therefore the price of front-line labor will go down substantially in the more advanced countries and will rise in the less advanced countries, until you get an equilibrium price (in economists' terms) for front-line labor worldwide.

And if you take that view, it's rather depressing, I suppose, from the national standpoint, especially if you happen to be in the front-line labor market, certainly for the country as a whole. But you can legitimately throw

your hands in the air and say, it's tough but there is nothing we can do about it—it's perfectly inevitable. That's reasonable, but it turns out not to be true.

When we looked, in fact, at what was going on among the advanced industrial countries, we found that whereas what I described was certainly the case with the United States, real wages have been going down in this country for 20 years—a 12% decline on average for real wages over the last 20 years, much higher for the bottom half and for most of our front-line workforce. However, that was not the case among a number of our leading competitors, places like Germany and Japan and other countries where real wages, instead of going down, have been going up. And productivity there, instead of being stagnant, was improving at substantial rates.

And so the crucial question gets to be: *what are we doing that they are not; what are they doing that we are not?* The answer turns out to be something as ubiquitous as the air and the water, or nearly so, something that we would rarely think about. It has to do with the way that work is organized in our various countries.

In the United States, where we invented the mass production method of doing work at the turn of the century, we absorbed its lessons and its methods more completely than any other country. In essence, what we did at the turn of the century was figure out how a relatively small number of an educated elite could create a form of work organization in which most of the work was done by people with very little education and less technical skill. We did that by organizing the work around machinery, analyzing the tasks that had to be done by human beings and could not be done by the machines, breaking those tasks down into very small components, and assigning no more than one component to a human being, such that that task could be learned by rote and repeated endlessly until it was done, as the guru of the age said, "with machinelike efficiency" by human beings.

It was a brilliant social invention. It made us the richest country in the world, and it made the people who did that work the richest and biggest middle class the world had ever seen. It's not an evil system; in my view, it was

a brilliant invention. Doing the work was not a whole lot of fun, but the people who did it lived like the kings and queens of only a century or two before.

However, what I told you at the beginning of these remarks is that the lessons of mass production organization have now been absorbed by countries all over the world, including a number of countries which are much poorer than we are by any measure, and they too now can have access to the same capital, the same machines, the same technology. They find it not too hard to educate their front-line workers, believe it or not, to the same standards that we educate most of our kids. And so they can make that system work for them, and they are producing highly marketable products for wages which are one-tenth, one-twentieth, one-thirtieth, one-fortieth, of what our wages are. If we compete on the same terms that they are, which are the terms that we have learned how to compete on for the last eighty or ninety years, we will in fact be making their wages. I am not telling you about future. I'm talking about what's happening right now and has been happening for twenty years.

What is happening in places like Germany and Japan is that they are organizing work differently from that model. They are giving to the people on the front-line the duties and responsibilities which we typically give only to professionals and managers. When we visited Japan and Europe, we saw front-line production assembly workers organized in self-managed teams, no foreman. On Monday of each week, they were given the orders that they were to fulfill for the week and they determined their own production schedule. They did their own parts ordering from internal and external suppliers. They sent back the parts that did not work. They did their own quality control, and they did their own equipment maintenance. They figured out how to improve their product, day after day, month after month, year after year, finding themselves in a close partnership with the company's engineers and product designers.

What I am describing to you is a great deal of work now done by professionals and by management. By having the people on the front-line do it, you vastly improve the quality of their work and you greatly improve

the quality of the product because most of these departments, divisions, and bureaus in the back offices go away or become much smaller. The communication lines become shorter up and down the organization and, even more importantly, across the organization. What you get out of this are three crucial things: an enormous improvement in the quality of the product or service, customized products and services, and very fast responses to changes in consumer tastes. Those are the three things that the world is willing to pay high wages for these days, and nothing else.

Other countries have learned that lesson faster than we have. We're sitting in the bowels of an organization that learned that lesson much earlier than most. Xerox in 1981-1982 nearly went out of business in the face of totally unexpected competition from Japan. In 1981, as I remember, they learned that Savin and a couple other firms based in Japan were able to produce and sell a product which cost the customer less than what it cost Xerox just to produce a comparable copier. That does not include Xerox's costs of marketing, transportation, distribution, and sales. Xerox totally reorganized, and they reorganized on the principle that I have just been mentioning.

We now need to have almost everybody coming out of high schools with a level of education and training pretty close to that which we now expect for kids going to selective colleges.

The only really big problem with this new form of work organization is that it requires a front-line workforce which is nearly as well-educated and trained as the professionals and managers. What that does is utterly transform the whole national skill training requirement. Instead of having a system, as we have had since 1920, in which only the top 15% or 20% gets much of any education and the rest is sent out of school with seventh or eighth grade levels of literacy, we now need to have almost everybody coming out with a level of education and training pretty close to that which we now expect for kids going to selective colleges. This is no mean change in requirement; it's utterly fundamental.

The natural question, if you are a policy analyst like me, is to say, *okay, if you have a number of countries out there*

that have figured this out before the United States has figured it out, what are they doing to meet the requirement? How and in what ways do our skill training and development arrangements differ from those of the countries with which we compete— those that are going the high wage route? Well, the answer to that is, *in every respect that you can imagine.*

One-third or more of our future front-line workforce is growing up in poverty...

Let me just illustrate the point. The level of poverty in the United States among children is more than twice that of any major nation with which we compete. About 22% of our kids are growing up below the poverty level. That's obviously a far higher fraction of our future front-line workforce, so somewhere in the nature of one-third or more of our future front-line workforce is growing up in poverty, many under perfectly miserable conditions. Before they ever get to school they have three strikes against them.

Once our kids are in school, the issue becomes academic performance. Perhaps the most telling comparison that I know of: about three years ago, the Educational Testing Service did the first international comparison on mathematics and science. Of thirteen-year-olds in Spain, England, Ireland, four Canadian provinces, and South Korea, our kids scored at or near the bottom in almost all categories, and South Korean kids scored at or near the top in all categories.

When you tell these kinds of stories to American teachers, they say *that's fine, but we educate everybody, they educate just an elite.* But the dropout rate in South Korea is half what it is in the United States. And, by common consent, all of the kids graduating from South Korea, which is 90% of the kids that go in, are fully literate. Which can hardly be said of the kids who graduate in the United States. So if you want to look at who's educating everybody, it's the South Koreans; if you want to look at who's definitely not educating everybody, it is the United States.

Perhaps the most interesting point of comparison has to do with what happens to kids who don't go to college in this country and in many other major countries with which we compete. About forty-nine percent of America's high school kids are in the general curriculum;

that is to say, they are neither in the academic or college-bound curriculum nor in the so-called vocational curriculum—the two of which combined account for 51% of our kids. Most of our future front-line workforce is in the so-called general curriculum. These kids, whether they graduate or not, come out with less than an eighth-grade level of literacy. I remind you of my Indonesia story: they are basically primary school graduates; in world terms, they are not secondary school graduates.

According to the best statistics we have from the United States government, they have never taken more than one course—vocational course—that will ever relate to anything they will ever do. So they come out with basement-level academic skills and no vocational skills—almost half the kids in our school system. When they do that, according to the statistics, the vast majority of them, having graduated high school, will go and get themselves a no-skill dead end job. They will keep it for a while, they will go on unemployment, they will get another no-skill, dead end job, followed by another period of unemployment, in several such cycles until they are 25 or 26 when they will get their first job with a company that will put them on some kind--any kind--of a career track.

In the United States, two-thirds of what a company spends on continuing education and training is spent on management--not the 70% of people who are on the front-line--and almost all of what is spent on the front-line is spent by 8% of our firms. 92% percent of our firms spend virtually nothing on furthering the education and training of their front-line workforce.

If you look across northern Europe, you will find that they care about their children. In most northern European countries there is a children's allowance: every time a mother has a baby, she gets money from the state, independent of her income. In Germany, the amount is about $1,600. The child gets an allowance, and the parent has access to paid, systemic, universal low-cost or no-cost health care. Unlike in this country, any mother who lives in one of those countries does not have to worry about prenatal care and advice, prenatal nutrition assistance, having her baby in a hospital under the care of a licensed physician, or follow-up care, meaning nutrition and

If you want to have a system in which you will capture the energy of the kids, then the first thing you have to do is make school relevant to them, in terms of what they want for themselves.

health care for her child postnatal. All of that comes with the territory, unlike in this country. The third major prop, if you will, in those countries is low-cost, or no-cost high quality day care of the kids. All of that is a kind of understood underpinning for kids in those societies, no part of which has ever been available widely in the United States.

In schools, what we found was a lot of things—it would take a long time to go into it all—but the most striking thing had to do with standards that were in place in all of the countries that we visited that had a high quality educational system. There wasn't a single country that we visited that had high quality education output from the schools that did not have clear standards, either curriculum standards or examination standards or both. This is important for two reasons. One is incentives, and the other is focusing energy and attention.

The incentives argument is very simple. In this country, the only kids in secondary school with any incentive to study hard or take a tough course are those kids who think that they are going to a selective college—a tiny handful of our kids. For all the rest, all you have to do is to get a diploma, and in most states, all you have to do to get a diploma is demonstrate a seventh grade level of literacy, show up most of the time, and not cause too much trouble—that's it. In most countries, whether you want to be an automobile mechanic or a brain surgeon or anything in between, the quality of the job that you get and how much it pays depends upon how well you do in school. Period. Full stop. Not true in the United States.

If you want to have a system in which you will capture the energy of the kids, then the first thing you have to do is make school relevant to them, in terms of what they want for themselves. There has to be some connection between how well you do in school, and what you want for yourself after school. There is none for 70 or 80% of American kids. School is a place where you park until life gets interesting, which is usually after school.

The other thing that standards do in these countries is

very simple. They say to the teachers, to the kids, and to the parents, *this is what kids are supposed to be studying*. In those countries, it turns out that the tests are supposed to be related to the curriculum. In this country, one is not supposed to teach to the test. In most countries, what you are testing is what the kids are supposed to be learning, and what the kids are supposed to be learning is supposed to be related to the curriculum, and the curriculum is supposed to be related to the standards.

A novel set of ideas for the United States, but not novel at all in most of the rest of the world. They have another novel idea: the way teachers are trained ought to relate in some way to what the kids are supposed to learn. Until now, we have never thought that was a good idea. The standards drive the incentives, curriculum, testing, teacher training, and instruction in most, if not all, of those countries.

I've described our system as alternating dead-end jobs and unemployment for about 7 or 8 years until you have your first real job. In most of those countries, it is not like that at all. The common education of all people is supposed to be completed around (age) 16 in those countries, not 18 as here in the United States. In most other countries the standards [of education]are nearly as high for kids who are not expected to go to college as it is for kids going to college, unlike here. Kids not going to college, in most of those countries, most of their kids-- on the order of 80%-- then go into some form of dual education system lasting two to three years and combining continued classwork with structured on-the-job training, working toward a qualification set by employers that is the same throughout the country. When they pass their written and practical exams at the end, they are well-educated and highly-skilled and they are more than ready to embark on a rewarding career.

Employer's relation to the schools is not a matter of charity. It is not a matter of philanthropy. It is a matter of business survival.

In this country, of course, business has never been expected to join with schools as equal partners. But now, employers' relation to the schools is not a matter of charity. It is not a matter of philanthropy. It is a matter of

business survival. What those of you from business need to do is to view this matter of business survival as a collective problem, as a collective challenge, and to do what you would do normally if you were facing a business problem which is what you never do if you face a charity problem which is to start off with an analysis of the nature of that problem and then put together a business plan and a strategy for solving it.

What those of you from business need to do is to view this matter of business survival as a collective problem, as a collective challenge, and to do what you would normally do if you were facing a business problem...

What I have noticed in Rochester, New York--where we are based--as in many other places, is that the businesses never got together and asked themselves, *what are each of us doing? What is the relative effectiveness of each of these programs? And, what lessons should we draw from that for what we should do collectively?* Which is absolutely what they would do if they thought they had a serious business problem. How serious is this problem? They'd gather all the data, they'd analyze it and then say, *Let's benchmark the best practice in community, in the state, in the nation, in the world, and then implement that practice or something that we think would be even better.*

That's what you would do if you had a business problem. It is never what you do if you have an education problem, because that's a public relations and a charitable issue. Now, the objective there is not to fix it; the objective is to get yourself in the newspapers, to make yourself look good, and produce no controversy. It's PR. That's a really strange way to treat the problem if in fact, the most serious business problem we face in the long term is the quality of front-line labor. You would then worry about that, as you would worry about any other supply problem which you have, and would go out and get it right. That's what we are trying to do in Rochester. We've basically got more than a dozen employers around the table analyzing this problem and saying, what do we have to do to collectively fix it? And, how can we capitalize on our resources to do it? And, when they say resources, they do

not mostly mean money. They mean other things. Let me illustrate the point.

First of all, we have a group of employers who have been working with the school district in developing a new school-leaving standard. A school-leaving standard high enough so that people who meet it will be able to function well in high performance workplaces, the kind of high performance workplaces these firms are creating. Now Eastman Kodak is among the businesses that don't employ young kids until they are in their mid-20's, like most of the other big employers in this country. Kay Whitmore, then the CEO, attended the first meeting of our standards-setting group, and he said, "If you and the school district will agree on a standard, and it is a standard that meets Kodak's high performance work organization requirements, we will recruit graduates from the Rochester City School District that meet that standard right out of school and offer them good jobs at Kodak." That will send a big message to the kids, right? Meet a predetermined standard which industry help set, and you get a good job at 18 in the most prestigious company in Rochester, New York.

And then there is the Wegman's Work Scholarship Program. Wegman's is one of the most highly-admired grocery chains in the United States. Wegman's has had a scholarship program in place for young high school kids working for the Wegman's supermarkets. If they maintained real good grades, Wegman's would provide them with a scholarship through college. One day, Danny Wegman looked at the data and said, "These kids are all white. Aren't there any kids from the inner city?" The answer was no, they can't meet the standards. Danny said, "We've got to do something about that." He went about doing something about it in exactly the way that he went about setting up a new product line for the supermarket. He talked to lots and lots of people in Rochester until he thought he began to understand the problem. And then what he did was, he went to the Rochester City School District and he said, "I want you to identify as scientifically as you can (and it turns out they have quite a scientific way of doing it) fourteen-year-olds who are very likely to be drop-outs at sixteen. I will interview those

kids and take in a bunch of them. I will offer them jobs in our supermarkets—at the checkout counters and the produce lines and all the rest of it." Obviously, like most other places, he doesn't typically hire kids at fourteen; he's doing that just for these kids. He offers them part-time jobs on the condition that they stay in school and that they start to do progressively better.

These kids were dropping out of school because they didn't believe in themselves, and because no adult believed in them.

He went to the scholarship students and said, "I want you to volunteer to tutor these kids in the classroom." He asked for volunteers on the checkout line and production areas to mentor these kids so that they do their jobs at Wegman's well. For every 30 or 25 of these kids, he hired one youth advocate to be their "mothers"—to be their parents, their cops, their probation officers, their mentors, their tutors. Because what Danny has discovered is what it took a lot of other people a lot more time to discover: these kids were dropping out of school because they didn't believe in themselves, and because no adult in their lives believed in them. And what he was doing was finding a way that a business could organize itself to provide the kind of support teams for these kids so that they would make it, and he did an unbelievable job of it. He was true to himself, and his image of what needed to be done and paid close attention to the data, which is what the operator of any good business does all the time. When I started looking at the data several years ago, I couldn't believe it. The school district prediction system was almost infallible; they had a lot of predictive power in their system. But about two-thirds of the kids in Danny's first group graduated—almost none of them would have without it—and about half of those kids were going off to college. And he gave them all scholarships, but what he then noticed was that these kids were not surviving in college. So he's now putting in place a system to support them once they're there because he wants them to make it all the way.

Danny then went and showed all of this data to the other businesses in town and couldn't get anybody interested in extending the program to other kids. If you other companies would put in at just this rate, he pointed out,

we could save all of the kids in Rochester. But these other employers evaluated his proposal in public relations terms, and it made no public relations sense at all, to put their money into a program with Wegman's name on it. So Danny said, "I don't care, I'll take my name off it." They said, "Well, it still doesn't matter, it's known as your program."

The issue of whether it was meeting a real need in the community with these kids evidently didn't arise. It is my point about whether this is a business problem, or a public relations problem. What Danny had done was to find a way to involve the guts of his business in providing a support system that would save these kids—something it's very hard for a school district by itself to do, or for any other kind of community organization, but a whole group of businesses can.

At about the same time, Eastman Kodak developed a very comprehensive program in mathematics and science called the *21st Century Learning Challenge*. There are now about 1,200 Eastman Kodak employees, including scientists and technicians, working on the development of mathematics and science curriculum, and working in classrooms alongside classroom teachers on mathematics curriculum in the classroom.

Kodak recognized that all the talk in the world about standards wasn't going to make any difference unless you actually changed what kids were taught and how they were taught. They recognized that they had an extraordinary resource in the technical personnel at Kodak, to make those changes. A lot of this is being organized as a volunteer effort, but all of it under Kodak's aegis. It is a very large and a quite successful program, which nicely matches what Danny was doing. Because if these kids don't feel that somebody cares about them, they aren't going to participate in that either. The problem with Danny's program is that it doesn't change what goes on inside the schools. The other program changes what goes on inside of the school. Put them together and you have a better chance then you ever had before of changing the outcome for these kids. We had weeks and weeks and months and months of discussion with the Kodak people and Wegman's people about how to marry these pro-

grams. Last year we started to develop a comprehensive program of health care apprenticeships. These programs will take high school kids at about their junior year and create health care technician programs for them working from national and local standards that will provide them with highly remunerative jobs in industry. We are starting to develop apprenticeship programs in several other fields as well.

In this case, the health care business becomes an educator or trainer itself, working hand-in-glove with the community college and the high school to provide a program none alone could provide. But you cannot do the whole job at the local level. The experience of one nation [contrasted with] another shows, I think very conclusively, that the standards that work are national standards. The reason for this in economic terms is perfectly simple. If I am thinking about whether I am 18 or 16 or 45 making a two-to-three year investment in skill development, what I'm going to ask myself is, *is this going to pay off?* I'm talking about giving up my money, my time, taking out loans, giving up my weekends, giving up my nights for two or three years.

It makes all the difference in the world whether the program I am considering enrolling in is made up of warmed-over courses designed twenty years ago, offered by people who haven't got a clue about the current state of the art, or whether in fact this program has been developed by a group of people who are very close to the industry. I have no way of knowing. What exactly is the industry? Does it mean one firm that's down the street? What if they have a set of requirements that are unique? Let me contrast that with the kinds of systems that they have in Germany and many other northern European countries. In those countries, the whole industry has gotten together from one end of the country to the other. They have set a standard based on what they believe to be the latest state of the art. They've got a standard broad enough to encompass not one occupation but many.

In those countries, when I go down the street and enroll in a program that provides education and on-the-job training leading to a certificate in the metal trades, I know that from one end of the country to the other, I'm

going to be able to walk into employers and they will honor that certificate. I'm going to be much more likely to make the investment of time, energy, and money that's required to get it. So what you have produced is an enormous increase in the investment in training. The employers are going to be much less likely to discount the training that I've got—they will know exactly what it is; they are the people who set the standards. That's what we desperately need--which cannot be done at the local level. It's crucial for business and industry to participate broadly in setting these standards.

If in fact you don't like the kinds of people who are getting out of your school system, like Kay Whitmore and the employers in Rochester, you have no one to blame but yourself because you never told the school systems what standard is the right standard. More important, you never said to the kids, *if you don't meet that standard we aren't going to employ you*. The message you've sent is, *we'll employ anybody who's got a high school diploma*. That's why standards are important, and that's why employers' participation in setting them is absolutely crucial. Some of you in this room are involved in some of those standards-setting efforts, and I applaud you. Many more should do it. If I am right and if things work, business and industry will be much less a cheerleader and a critic and much more an equal partner in the process. Business and industry will view its relationship to education and to early training, not as a matter so much of charity and public relations, but as a matter of getting one of its poor suppliers straightened out. You will become less a consumer and more a producer of education and training. These are not minor changes they are fundamental, they are structural. If we don't do it, were not going to make it.

If I am right and if things work, business and industry will be much less a cheerleader and a critic and much more an equal partner in the process.

Thanks.

AUDIENCE QUESTIONS

Question: What would it take for business to change and move toward high performance work systems?

Tucker: Well, I think that it's going to be led by those companies most engaged in the effort to make Total Quality Management work. And those are typically medium-to large-sized companies that are subject to enormous foreign competition and which, in fact, know they cannot compete on the basis of cost—that is, those companies that know that the only survival strategy available to them is one that's based on quality. And that's essentially what Xerox figured out in the early 1980s. There's a growing number of such companies in the United States. There's a story in my book about Motorola—the story of a lot of major American corporations—in which they decided to go with quality, and they set up Motorola University. They conceived of Motorola University as an institution built and run by Motorola, which would essentially give MBA's to Motorola managers. They saw it as a manager problem. And then they discovered that the problem wasn't managers at all. They discovered that the folks on the floor couldn't read or write English. They didn't know enough math or science to do any of the statistical quality routines. Their whole business plan went up in smoke. If they didn't do what they had to do they would lose the cellular phone business. So they ended up quadrupling their spending on the front line, essentially giving them skills they had never gotten in high school and more, which they had to do.

When I first came to Rochester, Kay Whitmore, the former CEO and chairman of Kodak, said to me, "You know, Marc, we've just spent the last year and a half coming up with a long range plan for Eastman Kodak, a ten-year plan." He said, "It was really going great guns until we started to actually set it up in our major plant in Kodak Park, and then we discovered that a third of the people on the front line didn't come anywhere close to having the basic academic skills required to take the training which we had programmed for them."

So what I'm saying to you is that the companies like Kodak, like Motorola, that are going for quality—that is, Total Quality Management—are likely to come to this as a matter of absolute business necessity, which is how Kay sees it. They didn't produce the *21st Century Learning Program* out of the goodness of their heart; Kodak is hard pressed, as anybody who reads the business pages these days knows.

That's where I see this coming from. It's going to come from the firms that see it as a matter of business necessity. Or it's going to come from smaller firms who see it as a matter of business necessity because the big firms for whom they are suppliers tell them, if you don't do this, you're out.

Question: It seems to me that the school systems have the same problem of recognizing and accepting that they have a challenge important enough to warrant fundamental changes. Could you approach that issue of getting everybody up to the same level so that we could all move forward?

Tucker: No easy matter. Let me be the first to acknowledge that. I think in some ways the easiest is the big cities because they know they've got a big problem and they're actually prepared to do things differently, more so than the others. It's the middle-to upper-class suburbs where everybody believes they're doing a wonderful job and if there's a problem, it's somewhere else—it's certainly not where they are! That's where the most resistance comes, in my view, to any of these kinds of changes.

But the first and a very large step is to get the standards right and to benchmark them internationally. I think the middle- to upper-class suburbs are going to find out, to their enormous chagrin, that what they're producing doesn't come close to international standards. I know it doesn't. The country as a whole doesn't know that yet, but it will. And as we begin to figure that out, I think you're going to see a new set of forces at work.

It's really sad for me to see all these middle- and upper-class suburbs talking about the kids who've gone to Harvard, Yale, Stanford and Cornell. Even the wealthiest of them have some proportion that they're preparing for

the front-line workforce, who are usually very badly prepared. Because nobody cares about those kids in those communities.

But I think it's got to be an interaction between the standards-setting exercise and the firms. Up 'til now, most American business executives have been quite willing to speak out on education as long as it got them in no trouble. As soon as it started to look as though it might get them in trouble, there's somebody tugging at their right arm saying, "Boss, it's not worth it; stay out of it." Well, [stay out of it] if you're not talking about anything important. But if, in fact, the kind of trouble was that the price of one of your major components or raw materials was going out of sight and somebody was tugging at your right arm saying, "Gosh, you're going to get us in trouble if you speak out on this," you'd say, "To hell with you. This is our business that's going up in smoke!" This is your business that's going up in smoke. And I think that there's a growing number of business executives that are willing to be outspoken on the issues, much more so than in the past, because they recognize that.

Interestingly, Japanese corporations think about their supply of front-line labor the way they think of their supply of any other crucial input. In Japan, they deal with contract high schools: each major production plant has a relationship with a particular set of high schools in the area. They go to those schools each year, and each school can expect to get a quota for the year from Toyota—we're hiring 35 kids this year, or 25 or 27 for this kind of job, that kind of job. Entrance to high schools in Japan is competitive, so if you're a principal, and it gets to be known that Mitsubishi didn't renew its contract with you last year, you are in deep, deep trouble. This is extremely bad news; you don't want that to happen. The result is that you will do anything you possibly can to provide Mitsubishi with the quality of pupil that they're looking for.

Imagine this set of incentives operating in American high schools. Nothing like that happens. Eastman Kodak has a relationship with East High School. It will continue only as long as East High School provides the kind of

quality people it needs; if it doesn't, it will got to West High School. Nothing, nothing like that.

I urge you to sit there—those of you from business corporations—and ask yourself, *How would you change the relationship with this suppler if the quality of what they provided mattered to you? How do you treat your other suppliers? Do you treat them this way?* We all know the answer to that. *There are other relationships possible.*

Question: In terms of the kids' motivation, this must result in a much closer view of what education needs to—in other words, connect to the industry, or where you're going with what you're learning in school? It seems to me that is disconnected, pretty much, in a lot of our schools.

Tucker: Yes, there's an enormous disconnect here. You see, it comes out of our collective history together. In most of the other countries I have visited, the idea that one of—and I emphasize the phrase "one of"—the major purposes of schooling is to prepare people for work is perfectly natural to the educators. They assume that's the case and always has been. In the United States that's not so. The reason, I think, is what I was telling you before, that the mass production system was more completely ascendant here in the United States than in other countries. The result being that, work was where you literally or figuratively had to leave your head, or at least your ideas, at the factory gate. Well, no right-minded educator would want to prepare students for a world in which they were meant to leave their head at the factory gate and to do the same mindless task all day long.

That's educators' mental image of what work is for the front-line, and it was not so far away from the truth for a very long time. In fact, for a lot of jobs today. What they don't know, and therefore are not readily prepared to accept, is that in the modern workplace—a high performance work organization-type workplace—that's not true. Increasingly, the best of our business organizations are looking for people who can think for themselves, who can function as autonomous human beings, who in fact will function according to educators' rhetoric about what they think is appropriate.

The irony of this is that the schools have become places that turn out the automatons that they refuse to turn out theoretically. And employers are now asking them to turn out the people they've always said they wanted to turn out but never have. That's what I mean by the disconnect.

So there's a basis for a conversation now. It's a very hard conversation to have, because the business people are so very impatient and the school people are so ignorant— just to be honest about what's really going on—and they aren't very much prepared to accept it without a lot of persuasion. And the best way to persuade them is to go take them for a visit, which very few business people offer to do.

These are two utterly different cultures. And there are no small number of people I've run into in business—former school teachers who escaped the school culture—who wouldn't be such bad ambassadors to the schools, inviting school people to come see what a modern corporation is and how it operates. I think that might help. We've got to get to the point where a majority of American school teachers think that preparing young people to earn a living is certainly not the only thing that they are there to do, but it's a legitimate and important one.

Question: Following up on that, what is the position of the NEA and other teacher organizations and associations in education?

Tucker: That's difficult. It's difficult because the positions that are taken by the national organizations are not necessarily those that are taken at the local level. The national organizations' positions on these issues I think you'll find, on the whole, are very encouraging. As a matter of fact, some of the national leaders of the AFT and NEA have been leading the fight for standards and for better relations with employers.

Thank you all very much.

PANEL PRESENTATION: PROGRESS OF STANDARDS REFORM IN SCIENCE, MATHEMATICS, AND TECHNOLOGY EDUCATION

Panelists:

Kenneth M. Hoffman
Professor of Mathematics
Massachusetts Institute of Technology and
Associate Executive Officer for Education
National Research Council (NRC)

Lida K. Barrett
Senior Staff Associate for Planning, Coordination, and
External Affairs
Directorate for Education and Human Resources
National Science Foundation (NSF)

M. James Bensen
President
Dunwoody Institute

Moderator:

Lea E. Williams
Executive Vice President
National Action Council for Minorities in Engineering, Inc.
(NACME)

In this panel presentation, three leaders in mathematics, science, and technology education shared their visions of systemic reform and how they could be achieved.

The first speaker, **Kenneth Hoffman**, is on long-term detail from MIT to the National Research Council (NRC), an independent, federal council created to advise the government and the public on science, engineering, and medical issues. Through various positions with NRC, including executive director of the Mathematics Sciences Education Board (MSEB), **Hoffman** has been closely involved in efforts to develop national policy and standards for math-

ematics education. Currently he is responsible for NRC's new Coordinating Council for Education, which links programs across the National Academy of Sciences in pursuit of national education goals.

The second speaker, **Lida Barrett**, is a mathematician and a former university faculty member and administrator. **Barrett** has served on several national boards and committees devoted to mathematics education reform. In her work with NSF's Education and Human Resources Directorate, she oversees a range of programs related to science, mathematics, engineering, and technology education, and has thought carefully about how to use federal funding as a catalyst for system-wide reform.

James Bensen, the third speaker, heads a nonprofit, endowed institute of technology in Minneapolis. Before assuming this position in 1989, he served as Dean of the School of Industry and Technology at the University of Wisconsin-Stout. **Bensen** takes particular pride in being named by the Wisconsin-Stout students as their distinguished teacher. Participants in the Synergy Conference received a sample of **Bensen**'s teaching style as he made the case for an integrated approach to reform that encompassed technology education.

Remarks of Kenneth Hoffman

Kenneth Hoffman
Professor of Mathematics, MIT
and Associate Executive
Officer for Education, NRC

What type of national strategy can effectively move an enterprise as vast and decentralized as the U.S. educational system—"a huge, loosely coupled system with absolutely no one in charge," as **Kenneth Hoffman** called it. **Hoffman** suggested a two-pronged strategy: first, "do it under the umbrella of national goals," and second, "figure out a way to make implementation happen at a local level."

Support for national goals and standards has come a long way since 1989, when NRC's MSEB first advocated mathematics and science standards in its report Everybody Counts. "Five years ago you could not say national goals for education out loud in this country," **Hoffman** said. "State educational agencies and governors would have laughed at that idea."

Today the situation is quite different, he noted. The mathematics standards developed by the National Council of Teachers of Mathematics (NCTM) are gaining wide acceptance, and science education standards are being drafted by an NRC-administered committee.

Hoffman's speech focused on some of the challenges involved in developing and implementing standards. A major challenge is to rally consensus behind a particular set of standards. In the U.S., said **Hoffman**, "no one can simply declare [standards] to be national." Rather, they become truly national when broad consensus emerges, and this is more likely to occur when all the major constituencies for education are involved in the standards-setting process.

"You can write down about ten big bloc constituencies," said **Hoffman**, "no one of which can positively move the system by itself, but any one of which can stop anything."

The standards being contemplated are demanding and will require dramatic changes in school structure and teacher behavior. To expect these changes to come about by normal processes alone is "very naive," he said. Thus, another challenge is to put in place a nationwide support system to help local communities sustain reform based on standards.

No nationwide support system exists now, **Hoffman** said, although a recent NRC study concluded that it would be valuable and feasible to design one. He predicted that before the end of the year a major effort to develop the necessary structural mechanisms will be launched.

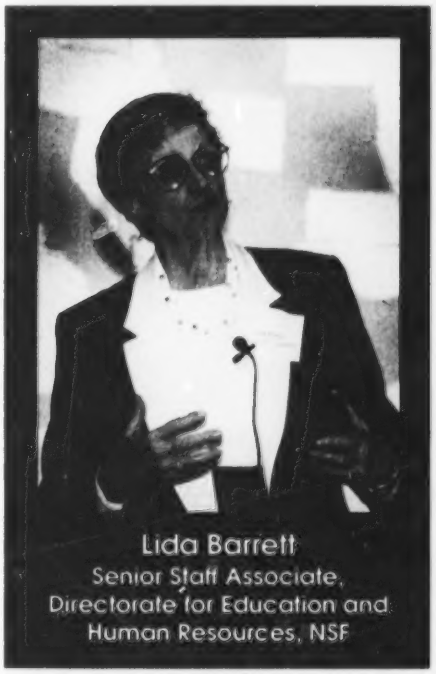
Still another challenge is to develop national standards that are meaningful but still allow for local flexibility. Explained **Hoffman**: "The trick is to learn how to articulate such goals with enough specificity so that they actually provide some coherence and guidance for the overall system, but not so specific that they infringe on the rights of the local authorities, the core curricula. And that's an art form."

Science education presents special challenges for national standards, **Hoffman** pointed out. Unlike mathematics, there is not a well organized K-12 curriculum, and many elementary schools have no science curriculum at all. Moreover, science is divided into disciplines at the secondary level.

The science standards project is attempting to meet all of these challenges and produce standards by the end of 1994. The process sometimes resembles "a living fishbowl," he said. "This is the single most watched project in the history of American education. It has an awful lot of onlookers . . . They all believe that if they were in charge of it, it would run better."

Remarks of Lida Barrett

Recently the NSF has undertaken a major shift of emphasis, **Lida Barrett** explained. Both its education grant programs and its administrative structure have been reorganized to move away from small, add-on research projects toward systemic reform initiatives. "A set of isolated points of light is not going to do it for us," she explained. What is needed, she said, are approaches that foster "fundamental changes in the existing structure of the educational system."



Lida Barrett
Senior Staff Associate,
Directorate for Education and
Human Resources, NSF

Barrett described several NSF initiatives to encourage systemic reform of mathematics, science, engineering, and technology education:

- Under the Statewide Systemic Initiative (SSI program), 26 states are receiving grants of $2 million per year for 5 years. With these funds, they are implementing coherent plans to leverage existing resources and improve their entire education systems. The availability of NSF funding has spurred all 50 states to develop plans that involve the governor, the state education agency, the higher education agency, business and industry, and other major players.

- A new urban systemic reform initiative targets the 25 cities with the greatest numbers of poor children. These cities may apply for grants to develop comprehensive reform plans that involve the mayor, the school system, and others. Two or three cities will receive grants to implement their plans, with more cities added as additional funding becomes available.

- A rural systemic initiative addresses the special factors that affect educational quality in small, isolated rural schools.

- The comprehensive program for broadening participation works with underrepresented groups in mathematics and science education.

• The multi-grade instructional materials development program helps develop curricula that promise to change content and instructional methods across the nation. Curricula must be designed with input from scientists and mathematicians and must be based on the best findings from education research.

• A program for systemic reform of undergraduate science and mathematics education is revamping the way that key undergraduate courses, such as calculus and chemistry, are taught.

• Three states have received grants for teacher collaborative efforts to reform teacher preparation on a statewide basis.

Underlying all these initiatives, said **Barrett**, is the common realization that "to move the system, there has to be comprehensive planning that involves the key leaders—the people who can create the roadblocks."

Barrett observed that the Administration's Goals 2000 legislation, now pending before Congress, would complement the NSF programs by using U.S. Department of Education (ED) funding to encourage statewide systemic reform plans. In fact, she said, NSF and ED have developed a joint statement of principle to fund only those curricular projects that are based on the NCTM standards or the emerging science standards.

Remarks of James Bensen

James Bensen
President, Dunwoody Institute

Too often initiatives to reform mathematics and science education leave out the technology dimension, said **James Bensen**—a short-sighted approach given the prominent role that technology plays in our economy and our everyday lives.

"You and I spend over 95% of our time in the built environment," he remarked, "which is encased within the natural environment. Even the farmer is living in a built environment."

Technology is spurring rapid changes in society and the workplace. Explained **Bensen**: "Ninety to ninety-five percent of all the technological knowledge has been put in place in the last twenty-five years." Moreover, the rate of technological change is speeding up. Paraphrasing Sir Robert Telford of the Marconi Corporation, **Bensen** noted that "sixty percent of the technology that the Marconi Corporation will be using by the end of this century—which I remind you is seven and a half years away—has not been invented yet."

These rapid changes have implications for workforce preparation, according to **Bensen**. Instead of dealing with a "cool, blue evolutionary kind of change" in which people carry out well-laid plans, the workers of the future must be equipped to confront a "red-hot, compressed revolutionary kind of change" in which the rules shift in mid-stream, he said. "Out there in corporate America, that is the world, and we have to be able to deal with those kinds of changes," he stressed.

Without technological knowledge, **Bensen** noted, our nation will not compete successfully on an international scale. One reason the U.S. is slipping in international markets, he noted, is because we sell raw materials overseas at low cost, where they are fabricated into high-tech equipment and sold back to us at higher cost.

Despite its preeminence in our culture, technology is often undervalued by our educational system. "We put a lot of emphasis on mathematics, science, and humanities, but technology is out there on the side," **Bensen** said.

The problem is not limited to elementary and secondary schools. Even college graduates, he said, "are coming out of colleges and universities with skills that have virtually zilch matched with the work world out there."

There are also humanistic reasons for integrating technology into systemic reform. "We do not live in an isolated, compartmentalized world," **Bensen** observed. "We are integrated whole human beings."

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Questions and Answer Session with Panel Members

After their speeches, the three panelists took questions from the audience, summarized below.

The first question was, *do all students need to know the same thing about mathematics and science?* Standards do not mean standardization, **Hoffman** explained, but national standards should apply to all students. "There is no contradiction between saying that these are standards for all kids, and saying that there still will be enormous variation in the extent to which kids learn various things," he elaborated. Nor is it necessary for everyone to take the same courses, as we know courses today, he added.

Barrett advocated moving away from thinking about courses in terms of Carnegie units. "We've got to look more at what our students need to know, not whether they can get it in a six-week period," she said, describing an NSF-funded mathematics program that integrated different mathematics, computer, and problem solving skills. A key to the program's success was that the University of California agreed to accept this course.

The panelists were asked how well the three interests they represented worked together and with other disciplines? NSF has not done a lot with technical education, said **Barrett**, although the agency's mission is broad enough to encompass technology. This should change, however, since Congress recently authorized new funding for this purpose and it is clearly part of the new Administration's agenda. In addition, she noted, other disciplines are following the lead of the mathematics teachers and moving toward standards-based instruction. The challenge will be to figure out how to unify the standards-based reforms for all subjects within a single local school or district.

Another participant asked whether technology education was being promoted by industry? "A lot of industries are not viewing the technology dimension as something that everybody ought to have, K-12," said **Bensen**. He felt strongly that secondary school is too late to begin and went on to describe an elementary program in which fourth graders "were working with lasers and optics and robotics and superconductivity" and learning about mathematics, science, and social studies in the process.

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Small-Group Discussions with Panelists

After the question period, Conference participants met in small groups for further discussions with the three panelists.

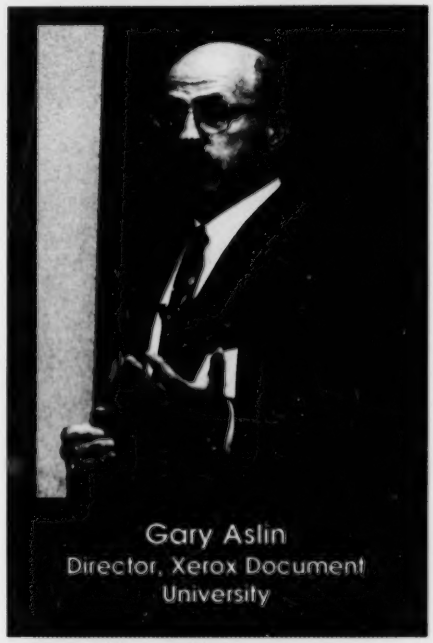
Among the issues considered were the historical factors that led to technology education being undervalued by schools and by society. **Bensen** attributed it in part to the history of work organization, which widened the dichotomy between merchants and workers. A parallel dichotomy eventually emerged in education between the theoretical and the practical. The result is that vocational or technical courses, no matter how effective, are not valued as highly as college prep courses, even though

skilled technical people may earn more over the long term than people with bachelors' degrees. Some educational institutions are trying to re-integrate the practical and the theoretical through programs that infuse technology education into science, mathematics, social studies, and other content areas.

Discussion also centered on how to change the way science is taught in K-12 schools. **Hoffman** felt that a massive mobilization effort was needed, involving the public and private sectors, and that national standards could provide a stimulus for local reform. Although the national standards may be imperfect, he said, they will form a base from which other improvements can grow. Already progress has been made in that people are talking about the need for all students to study science every year.

LUNCHEON SPEECH: BUSINESS AND EDUCATION: THE EVOLVING AGENDA

Gary Aslin
Director
Xerox Document University



Gary Aslin
Director, Xerox Document University

Gary Aslin manages Xerox's Leesburg training facility—one of the largest industrial training centers in the world and the site of the Synergy Conference. Xerox is an acknowledged leader in reorganizing the workplace around principles of Total Quality Management and in training front-line workers to meet new demands.

Change—in the workplace, the workforce, education, and corporate America's role—was the subject of **Aslin**'s presentation. "We now consider last year's processes to be old- fashioned and yesterday's products to be obsolete," he said. "In fact, a popular theory today is if it isn't broken, break it!"

In the workplace, a declining percentage of workers are involved in production contrasted with a rising share in services. Newer technologies are replacing older ones, and electronic communications are changing the way information is exchanged. A greater share of workers are women, immigrants, and members of minority groups. New work team arrangements mean shared job responsibilities.

Parallel changes must occur in the workforce, said **Aslin**. To be successful in today's work environment, employees must be responsible, self-initiating and able to work with others.

Education is not doing a good job of preparing young people to meet these changing employment needs, said **Aslin**, although schools are not entirely to blame. Rather, it is a shared problem.

Business-education partnerships, such as those undertaken by Xerox, are a major part of the solution. "If we are to maintain a leadership role in the world community," he concluded, "American business and American educational systems and institutions must significantly expand the number and variety of partnership activities and opportunities. We simply cannot fail to do otherwise."

BRIEFING: LEGISLATIVE INITIATIVES IN THE 103RD CONGRESS

Gary Allen
Director of Governmental Affairs
Triangle Coalition for Science and Technology Education

Gary Allen, the Triangle Coalition's advocate for science and technology issues and an experienced observer of the political scene, assessed the outlook for education legislation in the 103rd Congress.

The federal government is on an emotional rollercoaster called a transition, said **Allen**, and the real issue is, "Can the new leadership of the Congress and the Administration move the government from gridlock to lockstep?"

As of mid-July, no new education legislation had passed the Congress. If one looks to the Clinton campaign documents for cues of Administration intent, one finds that none of the President's stated education priorities "reflects a clearly articulated goal or commitment in the area of science, mathematics or technology," he observed.

Nevertheless, he said, legislative activity is probable on several fronts. First, there is likely to be a commitment to reaffirm the National Education Goals and strengthen support for voluntary standards through enactment of the Administration's Goals 2000 bill. While both of these federal actions have been long awaited by many in the science community, the Goals legislation is not without its problems, according to **Allen**.

For example, he said, the bill allows each state to submit to the national certification panel a set of goals that need only be comparable in quality and rigor to the national standards. "There is an essential missing word if you stop to think about it," he said, "and that word is

content." Thus, states could emerge with fifty different sets of content standards, which was not intended by many advocates of standards-driven reform.

An "education flexibility" section of the Goals 2000 bill—intended to give states greater latitude in federal program administration, reporting, and coordination—also contains language that could threaten mathematics and science education funding, **Allen** said. Not only may the Secretary of Education waive federal regulatory provisions; he or she may also waive statutory requirements. This means that states could seeks waivers of critical requirements of the federal Eisenhower Mathematics and Science Education program so that funding would no longer be dedicated to professional development or even to science and mathematics.

The Goals 2000 bill creates a new council to certify national standards for workforce preparation—a provision that **Allen** characterized as being poorly coordinated with the provisions for national "academic" standards. And, he added, an amendment to the bill in the House Committee exempted from workforce standards all occupational groups associated with apprenticeship programs.

The outlook for significant new funding for education is not bright, said **Allen**. The President's budget contains a real increase of less than $100 million for education, mostly targeted for the Chapter 1 program and the Goals 2000 initiatives. At the same time, the budget would eliminate more than 100 categorical programs. The problem, he explained, is that new money cannot be found without some hard trade-offs. One bright spot is the increased funding enacted for fiscal year 1994 for the NSF.

Another major issue on the Congressional slate is the reauthorization of the elementary and secondary education programs, including Eisenhower grants. A critical question, said **Allen**, is whether Congress will enact proposals that would consolidate several programs, including Eisenhower, into a state block grant.

Allen urged the mathematics and science community to track the Technology for Education Act, S. 1040. This bill authorizes $375 million to stimulate state technology planning, provide access to modern learning technologies among poor school districts, and support technical assistance and teacher training consortia related to technology.

Allen briefly mentioned a few other activities:

- Several new education bills strongly encourage business partnerships, but none provide money to support them.

- National service legislation is moving through Congress.

- The reauthorization of the Office of Educational Research and Improvement (OERI) within the Department of Education (ED), which has been subject to controversy in the past, is being taken up this year.

Allen concluded by observing, "Education will probably not be substantially reformed in Washington in the first session of the 103rd Congress."

CONCURRENT SESSIONS

On Thursday, June 24, participants could choose to attend five different concurrent sessions from among fifteen offerings. Most of these small-group sessions showcased examples of industry initiatives for education reform, and five sessions focused on national standards in mathematics, science, and workplace skills.

Sessions 1 - 4, Business as Advocates for Standards-Based Reform

This sequence of four coordinated sessions reviewed the status of national standards and curriculum reform in mathematics and science. Speakers invited feedback from participants on the emerging science standards and stimulated discussion about corporate involvement in standards-based reform.

Speakers:

William C. Linder-Scholer
Director of Community Affairs
Cray Research, Inc.
Representing the National Committee on Science Education Standards and Assessment

Robert J. Kansky
Associate Executive Director
Mathematical Sciences Education Board
National Research Council (NRC)

Elizabeth K. Stage
Director, Critique and Consensus
National Science Education Standards Project
National Research Council (NRC)

Carlo Parravano
Merck Institute for Science Education and
National Research Council (NRC)

Education reform in the 1990s is systemic reform based on voluntary national standards and assessment, said **William Linder-Scholer,** with mathematics and science leading the way. **Linder-Scholer** offered a working definition and some key tests for determining whether mathematics and science reform endeavors are truly systemic. (See box below)

DEFINING SYSTEMIC REFORM

SYSTEMIC REFORM IN MATHEMATICS AND SCIENCE EDUCATION:
The development and implementation of a national system of goals and assessment for curriculum, teaching, and evaluation. Key tests of any new endeavors—

1. Fundamental change (not tinkering at the margins)
2. Comprehensive and coordinated (not piecemeal)
3. National in scope (not strictly local)
4. Performance driven (outputs rather than inputs)
5. Universal (rather than elitist)
6. Benchmarked against internationally competitive standards.

Source: **William Linder-Scholer,** Corporate Council for Mathematics and Science Education

Corporate Roles in Systemic Reform. Business can be either a major force that promotes standards-based reform or an inhibitor that reinforces barriers to reform. For example, noted **Linder-Scholer,** most current models of business organization reinforce an outmoded education paradigm. Most business education outreach efforts also have major shortcomings, in that they focus exclusively on local activities, shy away from addressing state policies, are not aligned with national education goals, use an exemplary project model rather than a systemic one, and stress goodwill partnerships over real change. Unless corporate education efforts are aligned with sys-

temic reform and national objectives, he stressed, they will be fruitless over the long haul.

Robert Kansky spelled out some promising short-term and long-term steps for corporate involvement in systemic reform. Over the short term—the next one to three years—efforts could focus on encouraging larger companies to incorporate standards-based systemic reform into their education outreach activities and on helping national business associations and trade groups align their education initiatives with national education standards.

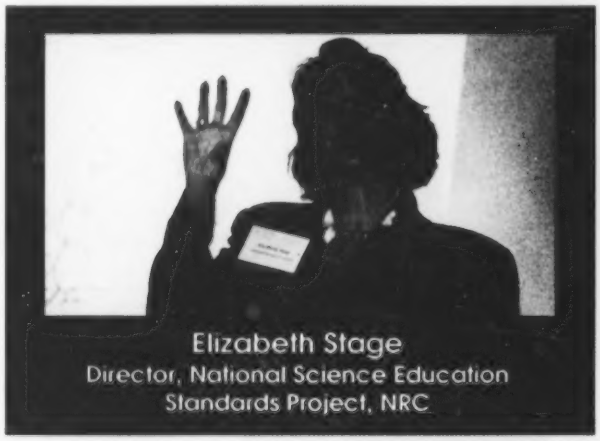
Over the long term—the next five to ten years—corporate energies could center on helping a substantial number of businesses and industries to:

- understand that standards are fundamental to K-12 reform;
- become directly involved in standards-based systemic reform;
- develop consensus within the business community on the importance and use of standards;
- enlist other partners, including universities, government, and schools; and
- sustain corporate commitment to standards-based reform and to a process of continuous improvement.

Overview of Standards. The sessions also reviewed the substance and status of the national mathematics standards now being implemented, and the developing science standards scheduled to come out in draft form by January 1994 and in final form by December 1994.

Both sets of standards assume fundamental changes in education, said **Linder-Scholer**. They would transform the nature of the disciplines themselves to reflect new content, new instructional strategies, and new visions of what it means to be mathematically or scientifically literate. Both sets of standards also advocate teaching their disciplines in the context of how they are actually used and how they relate to other disciplines.

Particularly significant is the assumption in both sets of standards that all students—regardless of background, future aspirations, or interest—shall be provided with opportunities to learn mathematics and science. Said **Elizabeth Stage**: "If every student is not engaged in learning science, then we have failed to meet our goal"; this, she said, means eliminating the sorting that routes students away from science study at a young age.



Elizabeth Stage
Director, National Science Education Standards Project, NRC

In other respects, the science education standards will be more extensive than the mathematics standards: they will address five key areas—the three essentials of content, teaching, and assessment, plus standards for programs at the classroom/school level and for policies outside the school. All five areas must be reformed simultaneously to influence the whole dynamic, **Stage** said.

With regards to science content—what students should know and be able to do—the standards committee is proposing to organize content around six categories: science as inquiry, physical systems, earth systems, life systems, scientific connections, and science and human affairs. According to **Stage**, this marks a different approach from the current science curriculum of biology, chemistry, and physics, which "was carved in stone a hundred years ago" and is in need of reorganization. In the area of teaching standards, the committee is encouraging teachers to assume a broader, more collegial role, she explained. The standards also will address the knowledge and skills that teachers should have and the professional development opportunities that they should receive.

The science standards are at a critical and malleable point of development, and feedback from the business community would be welcome and timely, **Stage** said. Input from business people, especially industrial scientists, could help ensure that standards address the practi-

cal, problem solving, and productive side of science, as well as the theoretical aspects advanced by academics. "I need a chemist from Dupont to be arguing with the chemist from Harvard," she said.

Business has much to gain from national standards. Standards will give meaning to a high school diploma, **Stage** asserted, and will help increase general scientific literacy. "It's good business to have a public that understands something more about chemistry than the current public does," she said.

Support Structure for Standards. A nationwide support structure is essential to the success of standards-based reform, said **Carlo Parravano**, and the corporate community could be instrumental in organizing and sustaining such a system. Efforts to create this system should be undertaken promptly, using existing coalitions if possible. "This may be one of the last chances once the standards hit the table," he warned.

Parravano recommended that the impetus for this system come from a non-governmental coalition builder—such as a corporate group—led by a strong visionary without a stake in a particular turf. In order to work, he said, a support network should also include teachers and should recognize that the movement for reform "must be embedded in the school system."

Parravano sketched out several possible roles that a corporate group could play in supporting standards-based reform.

These include:

- building a local base of political support;
- organizing coalitions of community leaders;
- preparing public information materials;
- helping schools develop effective strategies for communicating with parents;
- providing resources within the community to facilitate restructuring;

- developing inquiry-based science curricula;
- developing high quality pre-service and in-service education programs;
- providing resources for professional development centers for teachers;
- holding the district accountable;
- evaluating the standards project;
- examining issues of scale and multiplier effects to reach a significant number of teachers; and
- recruiting more corporations to become engaged in systemic reform.

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Session 5: Effecting Change in Elementary Science Teaching

Carlo Parravano
Director
Merck Institute for Science Education (NJ)

The Merck Institute for Science Education was established in 1992 with a ten-year mandate to improve the quality of science education at the formative K-8 grades. **Parravano** described the Institute's experience piloting programs with four school systems, three in New Jersey and one in Pennsylvania.

The Institute's programs focus on four areas:
- professional development for current teachers;
- reform of teacher education;
- creation of a resource center where teachers and administrators can obtain state-of-the-art materials; and
- policy support at the local, state and national levels to support systemic change.

Underlying Merck's efforts is a shift away from a project-based model for corporate/school partnerships to a systemic model, in which key players in the system are change agents and the goal is long-term reform.

Teachers in the four pilot districts participate in professional development and receive a high level of technical assistance, **Parravano** explained. Merck scientists and expert teachers serve as mentors to new teachers and student teachers. Assessment of results is an important component.

Parravano shared some lessons about the best practices that the Institute has gleaned from its experience and research. The most promising teacher development programs, he said, build on existing teacher beliefs, provide support beyond a one-time workshop, identify teacher leaders who become enthusiastic change agents, and take into account the realities confronting teachers, such as outmoded facilities. It is also important for teachers to have a sense of ownership of the reforms and the freedom to take risks, he said.

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Session 6: Providing Scientific Work Experiences for Teachers

Kaye Storm
Director of Special Projects
Industry Initiatives for Science and Mathematics Education [IISME] (CA)

Lauren Williams
Associate Director of Program Planning
Triangle Coalition for Science and Technology Education (MD)

Providing mathematics and science teachers with summer scientific work experiences in industry, government, and other settings is a cost effective way to improve education. The best of these work experience programs expose teachers to real-world science, connect them with a larger community of professionals, and give them a chance to reflect on their own teaching. According to

Kaye Storm, there are about 90 scientific work experience programs around the country, serving over 5,000 teachers nationwide. Most of these programs are fairly new, with an average age of about 3.5 years. On average they serve 19 teachers per program. Government laboratories sponsor about 42% of the programs. About 36% are sponsored by industry, with an estimated 430 companies and businesses involved in sponsorship.

The second oldest science work experience program for teachers is the Industry Initiatives for Science and Mathematics Education (IISME), a joint initiative of California Bay Area industries and the Lawrence Hall of Science in Berkeley. In nine years, IISME has provided summer fellowships to 675 teachers; by 1995, the program expects to serve about 25 percent of all high school mathematics and science teachers in the Bay Area. IISME fellows work in over 60 industry sites and government research labs. Participating teachers have multi-week, substantive summer jobs with mentored supervision; salaries are uniform and competitive.

According to **Storm**, participating teachers not only gain in self confidence and professionalism, but also change their instruction, emphasizing teamwork, problem solving, new technologies, real world illustrations, corporate culture and professionalism, and more. Industry also reaps benefits beyond community recognition. Teachers bring strong communication and technical skills, new perspectives, and enthusiasm, as well as employee morale.

The Triangle Coalition and IISME collaborated to expand the IISME model nationwide through the SIFT/ ISSME Program. The organizations provided planning and implementation materials, brought diverse partners together, and guided them through the implementation process. Twelve new programs came on board as a result. The Triangle Coalition, IISME, and other scientific work experience programs for teachers are collaborating to further expand these professional development opportunities nationwide. The new effort, called the SWEPT

Program, will produce a videoconference, video, and written dissemination materials. The Coalition will coordinate the SWEPT Program which relies heavily on the experiences of its partners like IISME.

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Session 7: Higher Education Outcomes Through National Industrial Cooperation

Doug Hull
Director General
Industry, Science and Technology Canada

Just two years ago, education reform was a dormant issue in Canada, said **Doug Hull**, director of the Canadian government's industry department. But publicized declines in student performance heightened parental concerns, and the national government responded with several new initiatives. Industry also stepped up its involvement, so that today, said **Hull**, "the biggest enterprise is education reform."

Hull described several mathematics, science, and technology education programs overseen by his agency. Largest of these are three undergraduate scholarship programs: one to encourage talented students to pursue science and engineering, another to persuade scholars to enter technology fields, and a third to recruit senior scholarship students as mentors to younger peers. A fourth scholarship program, funded by industry, gives extra aid and summer jobs to the cream of the scholarship students and helps connect them with top jobs in industry.

A Prime Minister's award program recognizes outstanding teachers in science, mathematics, and technology—"to make them national heroes," said **Hull**.

One of the most popular and successful Canadian initiatives is the *Innovators in Schools* program, which recruits current and retired scientists, engineers, and

technicians to volunteer in schools as mentors, demonstrators, curriculum advisers, and resource people. Attracting a surprisingly high number of volunteers, this program has helped cultivate corporate/school linkages and increase student interest and teacher confidence in science.

Other Canadian government programs aim to:

- link Canada's 20,000 schools electronically, especially those in remote areas;
- donate surplus government and business computers to schools;
- promote public awareness of science, mathematics, and technology education; and
- increase participation of women in science and technology.

Like the U.S., Canada has recently grappled with the issue of how to exert greater federal leadership in education in a nation that has no national standards or curriculum, no national testing, and no national goals for education. "Working with schools directly is an important way to go, but it's not enough," **Hull** said. "There has to be a clear articulation of the outputs that business and government require."

After rejecting the option of national standards as infeasible, the government consulted with business and endorsed an industry-led initiative to develop a Basic Employability Skills Test to measure academic and other core competencies. "What we want to do is give an early signal to parents and teachers and schools about the types of skills needed and the students' ability to achieve those skills," said **Hull**.

This test, to be implemented in 1995-96, will build upon employability skills profiles already developed by the Canadian Corporate Council on Education. The test will be mandatory for all prospective employees who plan to enter the workforce after high school graduation, with participating companies deciding how to use and weigh the results.

Session 8: Mathematics and Science Enhanced Contextual Learning

George Taliadouros
Technology Specialist
Minuteman Technical School (MA)

At Minuteman Technical School, a two-year program called *Principles of Technology* combines academic and applied science to improve the knowledge and motivation of "the great middle unprepared and unfocused fifty percent" of secondary school students, **George Taliadouros** said.

In developing the program in 1983, the Center for Occupational Research and Development (CORD) started from the premise that the American science curriculum, characterized by separate disciplines and vertically organized courses, was disjointed and ineffective for most students.

Principles of Technology takes a different tack. Major scientific concepts, such as force, work, and resistance, are traced across the major energy systems—chemical, fluid, electrical, and mechanical. Students learn mathematics, physics, chemistry, and other academic subjects through a hands-on approach that also builds an understanding of technology.

Students who successfully complete the program are guaranteed a job after graduation with a starting salary in the mid-$30,000's and opportunities for substantial raises. The program is backed by several industry partners, including General Motors and Digital Equipment Corporation (DEC), and the curriculum is driven by a business advisory committee.

Principles of Technology has helped dispel the notion that physics is only for gifted students, **Taliadouros** noted. Even students with initially poor reading skills have succeeded in the program, as have adult displaced workers.

Taliadouros made a compelling case for using an integrated, hands-on approach to teach mathematics, science, technology, and computer skills to all students, including the college-bound. This model produces people who can adapt well to a rapidly changing economy, he argued, citing an anecdote about a roomful of Ph.D.'s in physics who could not fix a malfunctioning laser that a technician fixed with a cheap thermal fuse.

Participants in this session had an opportunity to interact with hands-on experiments set up around the room. These experiments, the same ones used at Minuteman Tech, engage students in such activities as streamlining shapes to reduce air drag or determining impulse and momentum in linear systems.

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Session 9: Workforce Preparedness: Family, School, and Community

Gregory L. Crosby
National Program Leader, National 4-H
U.S. Department of Agriculture Extension Service
[USDA] (Washington, DC)

Working with the private sector, the USDA and the National 4-H Council are developing a workforce preparation model that takes advantage of the broad reach of the USDA Extension Service to connect children with learning experiences in their local communities. **Gregory Crosby** explained how the model is evolving.

A USDA demonstration program begun in 1992 with the American Honda Motor Corporation pairs at-risk youth with community mentors. In addition, students participate in hands-on learning with cars and motorcycles at Honda's 17 technical training sites, then carry out a service project in their community.

The program has yielded positive returns, said **Crosby**. Students not only are exposed to the world of work, but also learn to work in teams, use technology, and improve their basic skills and thinking skills.

Based on findings from the Honda program, USDA and the 4-H Council are developing a general model to be implemented at other sites. Issues being considered are how to increase the involvement of families, how to provide outside learning experiences year round, and how to track the students as they progress in school.

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Session 10: VISION for Teacher Enhancement in Science, Mathematics, and Technology

Robert G. Meeker
Executive Director
SRC Education Alliance (NC)

The SRC Education Alliance, a consortium of the 60 largest semiconductor companies, decided that the best way to encourage more young people to enter science and technology fields would be to invest in teacher enhancement, said **Robert Meeker**. Thus was born the VISION program, now in its fifth year.

VISION is a partnership of schools, industry, and universities operating at three sites in North Carolina, California, and New York, with plans to expand to Oregon. VISION has reached 188 teachers so far (primarily high school teachers), who in turn have directly influenced 41,000 students.

VISION teachers spend part of their summer in the laboratories of semiconductor manufacturers, where they learn about industry applications. The rest of the summer is spent at a participating university, where they study relevant science and engineering theory. During the

school year, teachers keep in contact through a telecommunications network.

Each partner contributes something to the program, **Meeker** explained. The businesses provide real-world technological experiences, time and resources of employees, and financial support. The universities provide leadership and expertise, graduate credit, and planning and coordination with the business site. Schools provide teacher mentors, release time, electronic networking capabilities, and funding. SRC serves as a facilitator, catalyst, and networker.

Projects are expected to become self-sustaining after three years. The program has changed from a highly structured one, with specific guidance provided by SRC, to a more locally-developed one, where sites establish their own objectives, he said. SRC is also working on an implementation guide that other sites can use to establish similar programs.

Evaluation is an important component. Explained **Meeker**: "A lot of us have to report to a board of directors who ask, What kind of return on investment am I getting for the dollars I'm putting into these programs?" The Center for Research in Science and Mathematics Education at North Carolina State has been contracted to do a formal evaluation of the program.

Session 11: Middle School Science Teacher Development Through NJ BISEC Residential Summer Institute

Willis B. Hammond
Research Associate
Allied Signal, Inc., (NJ)

Gertrude Clarke
Executive Director
New Jersey Business/Industry/Science Education Consortium [NJ BISEC]

NJ BISEC is a consortium of corporations, schools, and universities that sponsors several education partnership programs. Among the most successful is an intensive, residential summer program for middle and high school teachers, funded in part from an NSF grant. According to **Gertrude Clarke**, director, NJ BISEC, this program could serve as a prototype for other groups around the country.

The centerpiece of the program is a one-week residential institute with three daily sessions on topical science, teaching, and industrial issues, said **Hammond**, research associate, Allied Signal, the main corporate sponsor. Scientists and technical personnel from participating corporations make presentations and interact with teachers. Teachers also visit laboratories and worksites. A distinguishing characteristic of the program is that it brings together all types of teachers, said **Hammond**—from top-flight teachers to "teachers who could use an extra push." Teachers receive $500.00 stipends to participate.

As **Clarke** stressed, the program is much more than a one-week opportunity; it is meant to encourage teachers to "break away from the mold" and take new ideas back to their classrooms. Toward this end, each teacher is assigned an industry person who is available for advice and assistance throughout the school year. Other forms of follow-up include meetings and evaluation sessions,

video instructional materials, classroom demonstrations by industry people, and exchanges of information about participants' projects. NJ BISEC encourages companies to pool their efforts instead of developing separate programs There are six primary corporate sponsors.

The speakers also mentioned some problems encountered during implementation. It is difficult for teachers and mentors from different parts of the state to maintain contact through the year, **Clarke** said. In addition, she said, more work needs to be done to improve teacher-initiated projects.

In response to an audience question, **Mr. Hammond** said that regrettably the program has not made a significant impact on how colleges of education prepare teachers to teach science.

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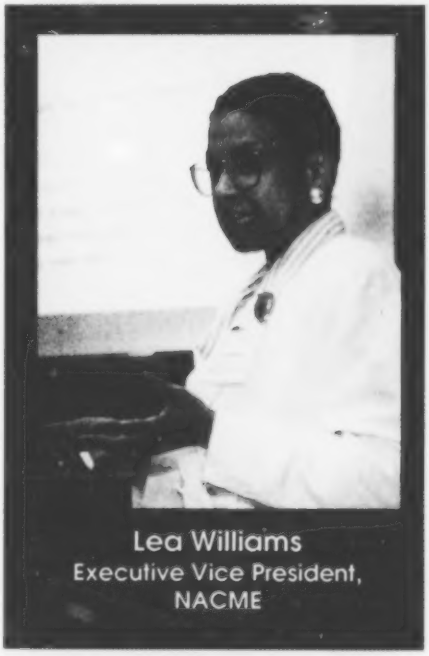
Session 12: Building Partnerships, Developing Linkages: The Corporate Education Connection

Lea Williams
Executive Vice President
National Action Council for Minorities in Engineering, Inc. [NACME] (NY)



Lea Williams
Executive Vice President, NACME

For twenty years, NACME has been in the business of developing corporate/education partnerships to encourage excellence in mathematics, science, and engineering. Now in its second generation of programs, NACME can offer models and advice to others interested in forging public/private linkages, said **Lea Williams**.

One NACME model is the *Corporate Scholars Program* (CSP), which grew from an effort "to build a better mousetrap" in a scholarship program, according to **Williams**. Initiated in 1990 with leadership from Amoco, Monsanto, and General Electric, CSP provides scholarships and other forms of support to exceptional African

American, Hispanic, and Native American students who are preparing for careers at the frontiers of technology. More than 120 students participate. Scholarships range from $12,000 to $20,000, with the amount tied to the student's grade point average.

The provision of enrichment beyond financial aid distinguishes CSP from other scholarship programs and contributes to its success, she noted. In addition to scholarships, students receive academic enrichment, mentoring, and career guidance. Scholars also participate in corporate work experiences, summer internships, and leadership development workshops. Corporate involvement is critical to the program. Fourteen corporations now sponsor scholars. Corporations benefit in the long term by expanding the pool of qualified personnel in fields with current or projected shortages.

NACME has also developed programs at the precollege level, one of which is the *McAllen/Mission Mathematics and Science Project* (M^3AS). Supported by Southwestern Bell Foundation, M^3AS seeks to raise achievement and interest in mathematics and science among fourth, fifth, and sixth graders in the predominantly Mexican-American communities of McAllen and Mission, Texas.

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Session 13: Mathematics and Science Teacher Academies

Michael A. Hopp
Director, Management and Organization Development
Martin Marietta Corporation (MD)

As a company employing 30,000 research engineers and scientists, Martin Marietta was accustomed to working with higher education, said **Michael Hopp**. In 1990, however, the company decided that it also needed to

address K-12 mathematics and science education to develop its future workforce. Enhancing the existing teaching force seemed to be the most promising way to improve student learning and motivation, he said.

The result was the Tennessee Academy for Mathematics and Science Teachers, the first of three academies now funded by Martin Marietta. Located at the University of Tennessee, the Academy is sponsored by a partnership of the University of Tennessee, the Tennessee Department of Education, Martin Marietta, and the U.S. Department of Energy, which oversees Oak Ridge National Laboratory.

The Academy operates as a four-week residential summer program and annually serves about 75 middle and high school teachers from five states. (Under an agreement with the State Department of Education, half the seats are reserved for Tennessee residents.) Teachers apply in teams that ideally include a mixture of mathematics and science teachers from both the middle and high school levels. The team approach helps teachers employ their new knowledge in their home schools, **Hopp** said.

The idea behind the Academy is to "give existing teachers an opportunity to walk a mile in the shoes of a practicing scientist," he explained. Scientists, mathematicians, and engineers—mostly from Oak Ridge and the University—serve as faculty. Teachers participate in extensive laboratory and field sessions, all of which are largely hands-on. Teachers also work on individualized projects to take back to their classrooms and learn how to obtain outside grants for new projects and materials.

An important element of the program is the follow-up commitment made by the home school districts. School systems must provide release time for teachers to attend follow-up conferences. In addition, a principal or curriculum supervisor must attend a three-day summer workshop on how to support reforms back in the district. Other forms of follow-up include computer networking, alumni meetings, and a monthly newsletter.

Martin Marietta has expanded the academy concept into Maryland and Florida, two other states where the company has a presence. Each academy has a slightly different bent, said **Mr. Hopp**, tailored to local circumstances.

The Maryland Academy, begun in 1992, added a Graduate Fellows program to an existing Governor's Academy for mathematics and science teachers. The year-long Fellows program seeks out enthusiastic, confident teachers who want to provide professional development to other teachers. The program includes a six-to-eight-week internship at a laboratory or company, ranging from a pharmaceutical lab to a wildlife refuge. Fellows take additional workshops before and after the internship and must develop a strategy for providing outreach to their colleagues in the subsequent school year.

The Florida Academy targets teachers in grades K-8 from three Central Florida school districts. Operated in partnership with the University of Central Florida, the Academy provides an 18-month, non-residential program that includes a four-week summer institute. Teachers who complete the program receive 30 hours credit toward a masters' degree and emerge as master teachers who will mentor their colleagues in mathematics and science. The goal is to have a master teacher in every school of the three districts within four years, said **Mr. Hopp**.

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Session 14: School Reform Through Partnerships

Barbara A. Sills
Director, Community Relations
Battelle (OH)

Pat Barron
Program Manager
Science and Mathematics Network of Central Ohio

Phil Heath
Research Coordinator
National Center for Science Teaching and Learning (OH)

"We in Central Ohio are moving partnerships along a partnering continuum, toward what we are calling a next generation of partnerships," said **Barbara Sills** of Battelle. What distinguishes these partnerships, she explained, "is that they are tied to reform: tied to changes in instruction, in curriculum, in classroom activities, tied to changes also in assessment." This is a very different approach from "popping in and doing a few 'gee whiz' things," she said.

The Science and Mathematics Network of Central Ohio was created to help develop and sustain the momentum of reform-based partnerships—to be "a neutral ground" where partners can explore tough questions, **Sills** said. Improving mathematics and science education in Central Ohio elementary schools is the Network's focus.
The Network began in 1991 with stimulus from Battelle and now includes people from business, museums, foundations, public schools, and higher education. A critical step in the formation of the Network, according to **Sills**, was Battelle's decision to start with the involvement of key people, then secure funding.

Real reform "is not just a compilation of good projects," said **Pat Barron**, the Network's program manager. In her view, successful reform-based partnerships tend to:

- be innovative and pioneering;
- involve hands-on, classroom-focused, and age-appropriate activities;
- grow out of long-term collaborative relationships;
- assess both student learning and the partnership process;
- bring partners together often—a few times a month, or weekly; and
- involve multi-level support.

"Just because scientists and technicians are in the classroom does not mean that there is good science instruction," **Barron** cautioned. It is important to change the culture of the school, she said, and this will occur only when teachers and scientists develop good working relationships, when they move forward together on an experiential curriculum, and when scientists become a normal presence in the school—when someone shows them "where the supply room is."

Building a research base on effective partnerships is a focus of the federally-funded National Center for Science Teaching and Learning at Ohio State, said **Phil Heath**. The Center has formed a relationship with the Network so they can check theory against actual practice. **Heath** described some of the Center's findings about characteristics of effective partnerships. (See box below.)

CHARACTERISTICS OF EFFECTIVE PARTNERSHIPS

1) Clear set of goals at the onset.
2) Benefits and/or rewards by each for the participants.
3) A clear concept of willingness to change by all participants.
4) Management by an organization or agency outside of education.
5) Perception of equality by each of the partnership members.
6) Purposes and organization of partnership dynamic over time.
7) Increased student learning of science—most important outcome.
8) Significance of the dynamics of the working groups.
9) Proximity of higher education institutions.
10) Cost shared by all participants.
11) Commitment for the "duration."

Source: **Phil Heath**, National Center for Science Teaching and Learning

It is important to involve unions and policy makers if the goal of the partnership is school reform, said **Heath**. Support from CEOs and superintendents is also critical, **Sills** added. Changes in K-12 instruction must also be accompanied by complementary changes in teacher preparation and higher education, **Heath** said, noting that higher education is often the most reluctant to change.

Ms. Sills discussed some of the common barriers encountered by partnerships, among them these "three killer phrases":
(1) "We're going to fix it for you." (Business speaking to Education)
(2) "We just need more money." (Education speaking to Business)
(3) "We're already doing this." (Anyone)

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Session 15: Partnerships and Performance: The American Electronics Association's Experience with Voluntary Skill Standards and Certification

A. Michaela Meehan
Policy Analyst
U.S. Department of Labor [DOL]
(Washington, DC)

The U.S. is the only industrialized nation without a formal system of national standards for workplace skills. To help rectify this, the DOL has established a program of demonstration grants to industry-led partnerships that will develop and implement skill standards for selected occupational clusters. These voluntary standards will address the skills employees need to perform successfully in the workplace, explained **Michaela Meehan**, the program administrator. Skill standards will also facilitate communication among employers, educators, and others involved in education and training reform, she said.

Thirteen DOL demonstration projects are underway, with nine more to be added soon. Several major corporations are involved, as are trade associations, labor unions, education agencies, and others. The American Electronics Association is leading one of the projects.

The process is not an easy one, **Meehan** explained. Some people perceive national standards as a threat to state licensing and accreditation boards. Others oppose a national assessment tool, which they feel will be the next step after standards. Achieving the right balance in the standards is a challenge, too, she said. The standards

Putting Our Heads Together: Kenneth Hoffman, *The Coordinating Council for Education,* and Lu Anna Stephens, *Texas Education Agency,* discuss a passage in one of the many publications distributed at the Synergy Conference.

Working Hard for Reform: Gary Allen, *Triangle Coalition,* and Cindy Musick, *U.S. Department of Energy,* listen attentively as Marge Dwyer, *U.S. Department of Energy,* describes her views on the future of science, mathematics, and technology education.

Response of the Participants

CHARGE TO THE WORKING GROUPS

The real output of the Synergy Conference came from the participants. Divided into four working groups, the participants were asked to:

- synthesize and react to issues raised by the speakers;
- develop, discuss, and share action plans; and
- formulate recommendations for group actions.

SYNTHESIS OF WORKING GROUP DISCUSSIONS

Several cross-cutting issues emerged from the discussions of the working groups. Some of the major points raised in group discussions are summarized below.

Issue: Why should industry be concerned about K-12 education?

Industry has traditionally devoted more attention to college and graduate education than to K-12 education, several participants agreed, even though the latter also directly affects the workforce. Many companies that hire highly educated people for scientific and engineering jobs have not looked down the road to see that without better science and mathematics preparation at the K-12 level, this pool will diminish in quality and quantity.

Particularly neglected are the students who do not go directly to college, even though they form the bulk of front-line workers, technicians, and in some cases small business owners. Mirroring this situation, companies spend the vast majority of their internal training dollars

on managers and professionals rather than on technical or front-line workers.

Conferees disagreed about the fairness of comparing schools to an ineffective major "supplier." Some people cautioned against pressing the analogy too far, because schools cannot be run exactly like a business and are subject to different forces. Still, many conferees wanted the same clear results from schools as they get from business suppliers.

The point also was raised that industry has a responsibility to do more than just criticize schools. Some participants noted that industry has been reluctant to tackle some of the really tough issues affecting school quality, such as teacher tenure and certification or inequities in school financing and local property tax bases—perhaps out of fear of being asked to pay higher taxes.

Issue: What are the different levels of industry involvement in education?

There was broad agreement that industry needed to move beyond individual projects, such as mentor programs or "adopt-a-school" programs, toward a higher level of involvement. As **Gary Allen**, director, governmental affairs, Triangle Coalition, said in a working group, "At the national level and in the most progressive corporations, we're well beyond adopt-a-school. If your company is still thinking at that level, you're eight years behind."

Working groups developed different yardsticks for identifying the levels of industry involvement. One group used a scale that began with small projects, then moved to model programs, and finally to systemic initiatives. Another worked from a partnership "continuum" with stages of no partnership, getting together, good projects, and reform-based projects. Yet another characterized the three levels as investment of dollars or employee time; membership in key organizations, committees, and governing bodies; and actual involvement in policy, standards, curricula, and other critical decisions. One partici-

pant felt that partnerships are often stronger when the funding stage comes after the membership and involvement stages, rather than before.

Whatever the delineations, it seemed clear from discussion that many businesses are still in the early stages of engagement. Small, discrete projects do not take much money and often are well accepted by the schools and community. As one participant remarked, "If you get overwhelming support [for your project], you are probably reinforcing the status quo." Several agreed that it helps to have an outsider, such as a state or regional organization, to nudge people beyond project-based reforms.

Issue: How can business and industry plan effective and comprehensive initiatives for systemic reform?

A company would not be likely to open a new plant without a business plan. Why not use the same approach to education, suggested several people, and develop a long-term strategic plan for your company's role in education?

Some groups discussed the potential elements of a strategic education plan, which include strategies for obtaining leadership from the top, securing a commitment over the long haul, and involving various community groups.

Issue: How can businesses judge whether a partnership is working?

Evaluating the success of corporate education initiatives is essential, many concurred. It is a poor investment of energy and dollars to continue programs that are not working. At the same time, many corporate sponsors, accustomed to quick returns on their investment, expect results sooner than is realistic with comprehensive reform initiatives. One participant urged industry to undertake long-term evaluations.

Several people recommended contracting with an objective group, such as an educational research organization or the Triangle Coalition, to conduct a formal evaluation of a partnership initiative or education program.

Issue: What are some of the barriers to effective partnerships for education reform?

Much discussion centered on common barriers encountered by partnership programs. One such barrier was the "disconnect" between industry people and educators, who speak different languages and have different agendas and perceptions.

Issues of turf, control, and bureaucracy constitute another set of barriers. Because the education system is so complex and has so many players and entry points, it is sometimes hard for industry people to figure out where to direct their energies.

Problems of "turfmanship" are not limited to education, however. Public relations motives often underlie corporate support for education initiatives, several participants noted, and sponsors are sometimes reluctant to share credit. This can discourage industries from collaborating with each other. Several people felt that companies should stop worrying so much about who gets the recognition and suggested that programs use a neutral name not identified with a single sponsor.

Other barriers mentioned included complacency or resistance to change, multiple demands on teacher time, limited funding, low motivation among students, low expectations for students, inadequate teacher training, political and legal barriers, and the lack of effective measures of school performance.

Issue: What are some broad strategies industry can undertake for systemic education reform?

Many participants stressed the need for better collaboration—among technicians and scientists within the same

company, among different companies and industries, among the scientific, mathematics, and engineering disciplines, and between industry people and educators.

Networking helps people learn about concrete models that can be replicated. There is a tendency, many agreed, for individual companies to reinvent the wheel, when they could be sidestepping mistakes and building on the successes of those who went before them.

Several participants agreed that teacher training can be an effective strategy for systemic reform. Others felt that business also should become much more involved in improving curricula in mathematics and science. Greater business involvement in the national standards projects was seen as an absolute must.

Finally, it was suggested that reforms target all three levels where policy decisions are made—local, state, and national. Most of the activity will occur at the local level, but these local actions will have a better chance of success if they are reinforced by policies and support at the other levels.

SUMMARY OF ACTION PLANS

Participants were asked to develop plans for actions that they and their organizations would take to promote systemic reform, including short-term actions that could be accomplished within a month and long-term actions that could be carried out within six to twelve months. Participants also were asked what specific help they needed from others to accomplish both short-term and long-term actions. Finally they were asked to note whether they found any ideas at the conference that they planned to use in their work and whether they had a contribution to make to the work of others.

The plans yielded an abundance of proposals for specific actions that not only will serve as a personal "to-do" list for their creators, but also might prompt others who did not attend the conference. The most popular ideas for action are summarized below, along with verbatim excerpts from actual plans. (The affiliation of the person who made each suggestion is shown in parentheses.)

Short-Term Actions

A typical short-term action was to brief colleagues, local partners, and others about what had been learned at the Synergy Conference and to share Conference materials. Several participants also said they would review and synthesize Conference materials for their own or their colleagues' use. Some participants said they intended to report to their CEO or board of directors about the Conference outcomes. Another frequently mentioned action was to contact people for more information about ideas, programs, or models discussed at the Conference. Several participants promised to send other people information that they had requested or to maintain communication with people they met at the Conference.

Several participants intended to call or set up meetings with key community players, including educators and business people, with the aim of planning an agenda or

beginning a dialogue about systemic reform. Many people hoped to become involved in their NSF-funded State Systemic Initiative. Reviewing and providing feedback on draft science education standards was another frequently mentioned action.

Following are examples of short-term actions from actual plans:

- Meet with our science education division and share Synergy Conference information and create action steps. (University)

- Help **Gary Allen** convene group of [my state's] business representatives to strengthen SSI effort. (Industry collaborative)

- Get VISION replication packet and **Lauren Williams'** evaluation of VISION from **Bob Meeker**. (Industry collaborative)

- Review our educational services plan and look for ways to incorporate new programs and information. (Business)

- Contact industry leaders, including our CEO, for comments on draft national science education standards.

- Provide feedback to E.K. Stage as requested. (Corporation)

- Set up meetings with school partners to take place over the summer. (Business)

- Contact [my organization's] public policy and legislative staff to be updated on research positions and legislative activities in this area. (Retiree organization)

- Assist state organizations in effort to organize a statewide focus group or conference similar to this one. (Community college)

- Work to increase CEO involvement in issues relating to school reform. (Corporation)

- Contact six to eight nonprofit or community service organizations within [my] industry to discuss group synergy. (Corporate alliance)

- Send material requested by others, e.g. "The Business of School" play that shows clash of school/business perceptions, ideas, jargon. (State Systemic initiative)

Long-Term Actions

A typical long-term action cited in the plans was to expand or reshape an existing industry partnership or program to stress systemic reform. Other plans proposed convening a local "summit conference" to develop a systemic reform strategy for the whole community. Several participants said they intended to become more active in groups already working on education reform, such as the SSIs. Others planned to initiate public awareness campaigns to educate company colleagues about the need for systemic reform. Several participants also intended to replicate models they learned about during the conference.

The following are examples of long-term actions from actual plans:

- Request our "ad hoc" board if they would like to evolve into a larger coalition similar to NJ BISEC. (University)

- Meet with key contacts in corporate, foundation, and local Science Literacy Initiative committee to help focus corporate strategy in the reform movement. (Corporation)

- Convene a roundtable of retired educator groups to examine, define role in systemic reform. (Retiree organization)

- Determine whether some of the programs I heard about at this conference can be replicated in [my state]. (State technology council)

- [Convene a] fall summit meeting with representatives of [my] industry to brainstorm synergy ideas. (Corporate alliance)

- Challenge our division of science education to include a "working with industry" component in teacher training. (University)

- Develop or begin to formulate process to educate/activate the school board members regarding mathematics/science standards. (State systemic initiative)

- Set up presentation by Battelle/SMNO. (Company)

- Develop an assessment vehicle. (Business)

- Follow up on the Technology in Education Act. (Industry collaborative)

- Review drafts of national science standards and provide conduit for drafts to our employees, teachers, and businesses. (Laboratory)

- Develop a menu of services to present to businesses. (Magnet school)

Help from Others

Information and materials were the types of help most often requested from others. Several attendees requested information on SSIs. Also of interest were updates on industry-education initiatives, science standards, and federal legislation. Participants also requested support for regional networking efforts, with some specifically requesting help from local Chambers of Commerce.

One plan asked colleagues for help in persuading the major national business organizations to develop a common plan and philosophy for systemic reform. A representative of a science institute asked for help from business in understanding what motivates business to invest resources in general education. "We do not have a good understanding of what motivates industry in this area," the plan said, "we are appealing to their hearts, not their profits and losses."

Ideas from the Conference

The answer to the question of whether participants found ideas at the conference that they planned to use was a resounding yes. Some mentioned specific programs or presentations, others mentioned general strategies. One participant said he appreciated learning more

about systemic reform in general: "Its need was obvious, but I did not have a framework to describe and communicate it to others," he wrote. Others cited the following lessons learned from the conference:

- Limit activities to put more into fewer areas for greater impact and enhancement. (Company)
- The concept that education reform is a serious business issue, rather than a public relations issue. (Laboratory)
- Will try to emphasize scientist/engineer partnering with teachers to more effectively use hands-on science kits that we lend to schools. (Laboratory)
- The State SSI's can be exerting some leadership with systemic reform. (State education agency)
- Will incorporate some of the data from the concurrent and planning sessions into my presentations. (Corporate alliance)
- Log on to IkeLinks. (Magnet school)

Contributions Participants Can Make

When asked whether they could contribute anything to the work of others, many participants expressed willingness to help in any way. Among the specific forms of help offered were feedback on national standards and information and technical assistance on their own best programs. Others volunteered to link business people to state SSIs. One participant volunteered to help set up another Synergy Conference in 1995.

Outcomes

The ultimate goal of the Synergy Conference was to produce an outcome that exceeded the sum of the individual action plans. Toward this end, working groups developed recommendations for joint actions to create synergy for systemic reform.

RECOMMENDATIONS TO THE TRIANGLE COALITION

The Triangle Coalition received the following recommendations from participants.

1. *Produce a standard definition of systemic reform.*

The phrase "systemic reform" means different things to different people. Three working groups suggested that the Triangle Coalition define this concept in a way that made sense to business people.

One working group offered a starting definition by proposing that systemic reform should:

- address the whole educational system, from pre-kindergarten through college;
- have a national base (but be implemented locally);
- include assessments that permit benchmarking against national or international standards;
- be relevant to the workplace; and
- apply to all students, especially as regards mathematics,science, and technology education.

2. *Make broader efforts to increase business and public awareness and understanding of the need for systemic reform.*

Many business people and citizens do not understand fully how K-12 education affects future competitiveness or why systemic reform of education is needed. A related recommendation was for the Triangle Coalition to publish a position paper that makes the case for systemic change and discusses how improvements in science and mathematics education fit into the larger context of education reform and economic competitiveness.

3. *Identify and disseminate case studies of model industry initiatives for systemic education reform.*

All four working groups made recommendations along these lines. As one participant noted, businesses are being bombarded with funding requests from science and technology education and need information to help them differentiate effective education programs from ineffective ones.

Participants requested concrete information on the mobilization strategies, funding procedures, collaboration strategies, and timelines used by model industry initiatives. One working group suggested that case studies be developed, incorporating the personal experiences of participating scientists, students, and teachers. A suggestion was made to disseminate the final product through existing regional information networks.

A related recommendation urged the Triangle Coalition to document effective ways that industry can influence state and local education policies, including legislative and regulatory decisions.

4. *Reach out to smaller businesses and involve them in local reform efforts.*

Many participants recommended that special efforts be made to educate small businesses about the importance of K-12 education reform and to suggest appropriate roles they can play in local systemic reform. Small

businesses are less likely than large companies to have an education initiative, yet they comprise a high percentage of the labor market and reach into communities where no large corporations are found.

5. Translate education reform language into terms that industry people will understand and want to support.

Too often industry and education people do not speak the same language, creating barriers to cooperation. If business people are going to rally behind systemic reform, they must understand clearly what the reforms entail. It was suggested that former teachers who now work for industry could perhaps help with this process.

6. Strengthen the connection between mathematics and science education standards and workforce skills standards.

The education standards and the workforce skill standards are developing along separate tracks. One working group felt that these standards should be better integrated, and joined where possible.

Several participants also felt that business groups have not been active enough in the development of national standards, partly because they do not have a strong enough foothold in the various standards committees. It was recommended that the Triangle Coalition help industry become a full partner in the development of national standards for all core subjects.

7. Coordinate regional "synergy conferences."

Several participants felt that a series of regional conferences would give greater momentum to the actions initiated at this Conference and would promote local and regional collaboration.

8. Develop and disseminate guidelines and strategies that teachers can use to seek appropriate resources and other involvement from business and industry.

Many teachers are unsure how to approach business and industry people; once the connection is made, they are often unaware of resources that industry can provide beyond mere funding. Since successful partnerships often grow from good relationships between key players, such as teachers and scientists, it makes sense to target the teacher as a pivot point for systemic change.

RECOMMENDATIONS TO BUSINESS AND INDUSTRY IN GENERAL

The working groups also developed recommendations for actions that industry in general could take to create synergy.

1. Recognize that many of your employees are parents, with enormous influence over their children's motivation and readiness to learn. Hold parent workshops at the work site, where issues such as the parents' role in education reform can be discussed.

2. Provide experiences at the workplace and in school to help students learn more about the world of work and become more highly motivated to learn. Offer workplace experiences for teachers to give them a broader and more realistic understanding of different work contexts.

3. Involve other grassroots community groups, such as organizations of retired persons, in your partnership initiatives.

4. Develop a corporate strategy for education reform that includes the following elements—

- the "buy-in" of your CEO and your corporate foundation;

- a local "caucus" that brings together the top-level business and education people in the community;

- multiple strategies for educating a diversified future workforce, rather than a single strategy for a monolithic workforce;

- a willingness to add reform-based programs to the corporate education agenda and, more importantly, to drop programs that are not contributing to systemic reform; and

- a strategy for educating potential partners about systemic reform and linking with other associations that can help leverage it.

5. Work with local teacher associations to set standards from the bottom up: industry would identify the work-place skills they want students to have, and teachers would identify the curriculum changes need to provide students with those skills. Put your words into action by hiring only people who possess those skills.

6. Make sure that the major business and industry organizations to which you belong incorporate an educational focus into their missions and support national education standards.

7. Promote the development and expansion of national electronic networks that teachers can use to reduce isolation, share ideas with colleagues, and access a wide range of scientific and teaching information.

Conclusions

SUMMARY OF CONFERENCE ACCOMPLISHMENTS

Evaluations of the Synergy Conference submitted by participants showed that the majority found it to be outstanding, well-organized, and productive. Most commented on the richness of the presentations and the ample opportunities for productive discussion. As one participant wrote, "I received a new understanding of my individual role in the whole picture of systemic reform."

The manageable size of the conference, particularly the concurrent sessions and small working groups, was conducive to brainstorming and idea exchange.

Conferees also were asked to note in their action plans whether they planned to use any ideas from the Conference in their work. The answer was overwhelmingly yes; many planned to use the model initiatives discussed at the Conference as a springboard for similar programs in their own communities.

Based on the action plans and evaluation forms, participants accomplished the following:

- Gained a better understanding of how global economic factors and educational quality related to their own workforce.
- Learned more about the status of voluntary national standards and the role of industry in developing and implementing them.
- Identified different levels of industry involvement in education and became convinced of the merits of moving from discrete projects to systemic reform initiatives.

- Developed an initial working definition of systemic reform in mathematics, science, and technology education.

- Learned more about successful industry efforts to contribute to systemic reform.

- Came to understand the characteristics of effective partnership programs and the barriers to be overcome.

- Took a hard look at whether their own programs and actions were really complementing systemic reform and made a commitment to undertake actions for improvement.

- Made meaningful contacts as a basis for future collaboration.

TRIANGLE COALITION ACTIONS ON RECOMMENDATIONS

1) The Triangle Coalition is seeking funding for the production of an Industry Handbook on Systemic Reform in Science and Mathematics Education. This handbook will contain an operational definition of "systemic reform" (recommendation 1, page 83) and place systemic reform of science and mathematics education within the broader education reform framework. It will contain some case studies of business/industry initiatives contributing directly to systemic reform (recommendation 3, page 84) and also will provide guidelines to help funders identify such focused programs.

2) The Triangle Coalition has scheduled the next of its popular series of Congressional Liaison Task Force meetings on the of topic workforce skills and science and mathematics education standards (recommendation 6, page 85).

3) The Triangle Coalition is actively seeking funding for a series of regional Synergy Conferences (recommendation 7, page 85). With its involvement in the National Govenors Association's series of six 1994 forums on education reform as well as its opportunities developing for collaboration with several SSI programs, the Coalition hopes to carry out purposes consistent with those of the June 1993 Synergy Conference. These conferences also will provide a platform for increasing business and public awareness of the need for systemic reform (recommendation 2, page 83).

The Coalition moved to implement the recommendations noted above in the Fall and Winter of 1993. It is aware of remaining recommendations and will respond to them through other Coalition activities. The June 1993 Synergy Conference and this report remain a rich lode of ideas for action not yet fully mined and will continue to help direct our actions over the coming year.

APPENDICES

APPENDIX 1 ▲ Funding

The Synergy Conference was funded in part by

American Chemical Society
Carnegie Corporation of New York
U.S. Department of Energy

cosponsored by

Aerospace Industries Association of America
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Edison Electric Institute
Industrial Research Institute
National Alliance of Business
Pharmaceutical Manufacturers Association
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and was arranged in cooperation with the

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Memorable Lines

"We now consider last year's processes to be old-fashioned and yesterday's products to be obsolete. In fact, a popular theory is if it isn't broken, break it!" --*Gary Aslin*

"Education is not going to be changed by add-on projects. It's going to have to be changed by funding changes in the existing structure of the educational system."--*Lida Barrett*

"Even those that have the skills to make it through college are coming out of colleges and universities with skills that have virtually zilch matched with the work world out there."--*James Bensen*

"Five years ago you could not say national goals for education out loud in this country. State educational agencies and Governors would have laughed at that idea." --*Kenneth Hoffman*

"The most important input for business is people, and what will make or break you are the skills of the people on the front-line workforce."--*Marc Tucker*

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APPENDIX 3 ▲ Conference Agenda

WEDNESDAY, June 23, 1993

10:30am Registration opens

12:00noon Lunch

1:00pm Welcome and Introductions

John Fowler, executive director, Triangle Coalition

Keynote speaker: **Marc Tucker**, co-author, Thinking for a Living: Education and the Wealth of Nations, and director, Center for Education and the Economy

1:45pm Discussion

2:00pm Break

2:15pm Panel: *Progress of Standards Reform in Science, Mathematics, and Technology Education*

Moderator: **Lea Williams**, executive vice president, NACME

Panelists:
Lida Barrett, senior staff associate for planning, coordination, and external affairs, Directorate for Education and Human Resources, NSF
James Bensen, president, Dunwoody Institute
Kenneth Hoffman, associate executive officer for education, Coordinating Council for Education, NRC

3:15pm Discussion

3:30pm Break

3:45pm Continued discussions with Keynote Speaker and Panelists

4:15pm Break

4:30pm Second Round of Discussions with Keynote Speaker and Panelists

5:00pm Recess

5:30pm Reception

6:30pm Dinner

7:45pm Plenary Session: *Charge to the Conference*
John Fowler, executive director, Triangle Coalition

8:00pm Discussion Groups

9:30pm Recess

THURSDAY, June 24, 1993

7:00am Breakfast

8:30am Plenary Session: Brief Previews of Concurrent Workshop Sessions

9:15am Break

9:30am Concurrent Sessions I

10:30am Break

10:45am Concurrent Sessions II

11:45am Break

12:00noon Luncheon

Business and Education: the Evolving Agenda
Speaker: **Gary Aslin**, director, Xerox Document University

1:30pm Concurrent Sessions III

2:30pm Break

2:45pm Concurrent Sessions IV

3:45pm Break

4:00pm Concurrent Sessions V

5:00pm Recess

6:00pm Dinner

7:30pm Coffee and Dessert Reception with Exhibits

9:00pm Recess

FRIDAY, June 25, 1993

7:00am Breakfast

8:00am Briefing:
Legislative Initiatives in the 103rd Congress
Speaker: **Gary Allen**, director, governmental affairs, Triangle Coalition

8:45am Plenary Session

9:30am Synergy Working Groups

12:00 noon Lunch

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